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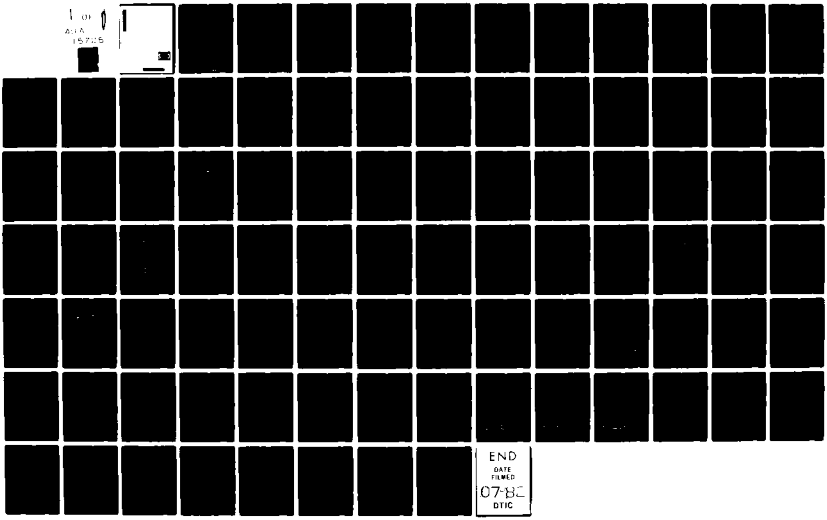

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This study is a follow-on to several previous studies funded by the Naval Air Systems Command for development of Maintainability Index Models. The report deals specifically with the term R&M Technology Improvement Factor (TIF) as used in the Maintainability Index Model (MIM) described in DTIC documents AD A 084627 and AD A 090563. The MIM R&M TIF value describes the percentage improvement (or degradation) which can be expected for a given new notional fighter/attack aircraft design. The MIM statisti-

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20. ABSTRACT (continued)

ically derives a predicted value for maintenance-manhours-per-flight-hour (MMH/FH) based on prior aircraft performance using design parameters such as vehicle weight or speed. The percentage difference between the statistical prediction and a contractor's submission is the R&M TIF.

This report describes the justification, and the rationale for determining the validity, or the reasonableness, of TIF's presented in a new weapons system design proposal.

PREFACE

This report was prepared by the Maintainability Engineering Group of the Vought Corporation, Dallas, Texas under Contract No. N00140-79-C-0445 for Naval Air Systems Command, Washington, D.C. The objective of this study was to address the differences between aircraft maintainability requirements derived from the Maintainability Index Model (MIM) and the aircraft maintainability requirements predicted by a contractor. Methodology for assuring technology improvements and evaluating contractor predictions is discussed.

This project was conducted under the technical cognizance of Messrs. George J. Donovan and Carl Tanger, Airframe and Equipment Branch, AIR-4114.

SUMMARY

The Maintainability Index Model (MIM) presented in the Aircraft Maintenance Experience Design Handbook provides a method of measuring predicted maintainability technology improvement of a notional system over a baseline of system operational experience and design parameters. The objective of this study was to provide the methodology necessary to validate this predicted technology improvement during the conceptual phase of a system.

The study addresses aircraft maintenance significant areas by system and subsystem, identifying those subsystems in which technology improvement will have the most significant impact on maintenance resources and requirements. The influence of technology, design philosophy, and commonality of systems on maintainability technology improvement also is discussed.

Methodology is provided for a subjective evaluation of predicted maintainability technology improvements in a system. In general, it will verify, with a reasonable degree of certainty, that improvement or lack of improvement that will result from innovations of the system design concept.

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1.0 INTRODUCTION

1.1 OBJECTIVE OF STUDY

The objective of this study was to address the differences between aircraft maintenance requirements as determined by the Maintainability Index Model (MIM) and aircraft maintenance requirements as predicted by a contractor during conceptual design. Methodology for assessing technology improvements and evaluating contractor predictions is discussed.

1.2 HISTORICAL BACKGROUND

Under an earlier contract from NAVAIR, reference (1), Vought Corporation developed a model for predicting baseline maintainability characteristics of notional Navy Fighter, Attack, and Anti-Submarine Warfare (ASW) aircraft. The model functionally relates aircraft maintenance characteristics at the two-digit Work Unit Code (WUC) level to aircraft design characteristics. A computer program, reference (2), is used to size the given conceptual aircraft for baseline maintainability requirements. The term baseline maintainability requirements is used to identify the maintenance requirements of an aircraft designed with the technology that existed when the active Navy Fighter/Attack/ASW aircraft were built. When baseline model data is compared with the contractor's maintainability predictions, the amount of technology improvement anticipated for the new generation aircraft can be measured. Units of measurement are maintenance man-hours per flight hour (MMH/FH), maintenance actions per flight hour (MA/FH) and mean time to repair (MTTR) at the Organizational and Intermediate levels of maintenance.

A user of the MIM must be able to relate the measured technology improvement with qualitative design features implemented in the new design. For example, if the model showed a 34% technology improvement in the Flight Controls System MMH/FH, an evaluator would want to know if this value is reasonable and whether the Reliability and Maintainability (R&M) design features stated in a contractor's proposal could result in a 34% reduction in MMH/FH.

1.3 GENERAL APPROACH

The approach taken to satisfy the study objective was to:

- Identify baseline maintainability requirements as determined by the MIM.
- Identify the maintenance significant items within a system and rank them by subsystem.
- Discuss the criteria for evaluating maintainability predictions.

2.0 MIM BASELINE TECHNOLOGY

2.1 MAINTAINABILITY INDEX MODEL

The Maintainability Index Model (MIM) determines baseline maintenance requirements for a given aircraft dependent on that aircraft's design characteristics. Statistical extrapolation of existing trends are used to establish baseline maintenance requirements as measured in maintenance man-hours per flight hour (MMH/FH) and maintenance actions per flight hour (MA/FH). These resultant values reflect some level of R&M effort commensurate to the technology that existed when the data base aircraft were built. This section will address the problem of increased weapon system complexity and equipment commonality on maintainability predictions.

2.2 AIRCRAFT DATA BASE

The aircraft used in the development of the MIM were initially designed to some level of R&M and that effort is reflected in the model data base. Unfortunately, increased weapon system complexity has overshadowed many good R&M features implemented in a design, compounding the problem of technology evaluation. Furthermore, changes in 3-M data over time have added another variable to the problem.

The existing model data base was compiled from Fleet experience of aircraft developed during the late 1960's and early 1970's and operating in the Fleet during the mid 1970's. Since then, maintenance expenditures on the aircraft used to develop the MIM has increased resulting in the model under predicting current year (1979) data by 40% and life cycle average data by 18% (reference 3). This has resulted in a program for updating the MIM on a periodic basis.

2.3 SYSTEM COMPLEXITY

History has shown that the addition of more parts, components, and equipment to a weapons system increases the probability of maintenance after a flight, resulting in higher MMH/FH expenditures. Although new technology has improved component reliability (failures per part per flight hour), it also has permitted an increase in density of functions and capabilities (numbers of parts per subsystem). This point is illustrated by Figure 1 which shows component reliability increasing over time while system reliability is decreasing. This has resulted in an overall increase in aircraft maintenance requirements.

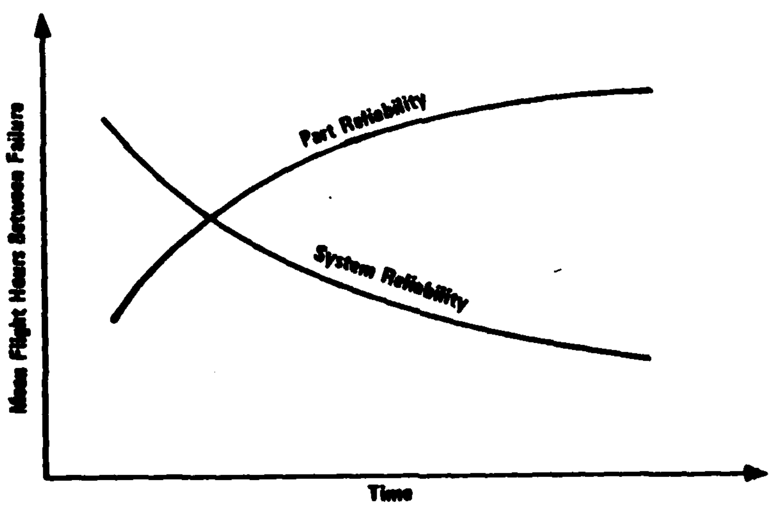


Figure 1. Technology Trends in Aircraft Reliability

The system level maintainability estimating relationships used in the MIM are responsive to this change and are thus useful in sizing a new conceptual aircraft design for baseline maintainability requirements. The primary design parameters affecting the model are aircraft weight, speed, and thrust.

Figure 2 shows how dependent total aircraft MMH/FH is on aircraft avionics weight relative to the year of first fleet delivery.

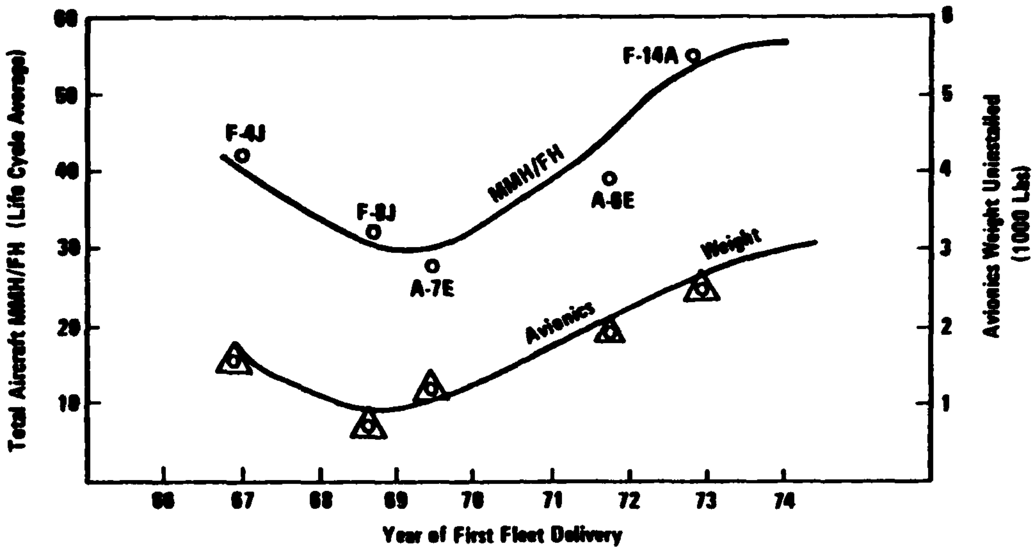


Figure 2. Aircraft Maintenance as a Function of Avionics Weight

Historical data showed that as aircraft avionics weight increased, so did system maintenance. This trend even held true for the newer generation of aircraft (F-14A, S-3A) with improved avionics equipment. One reason for this trend was that advances in design technology were off-set by the addition of more equipment to the aircraft. Consequently, it becomes exceedingly difficult for a new aircraft to show a significant reduction in maintenance and support costs as long as performance and capability increase.

2.4 EFFECTS OF TECHNOLOGY ON MAINTAINABILITY

The MIM was designed to be responsive to advances in design technology and improvements in reliability and maintainability. The model can accept or measure the net technology improvement predicted over a baseline design depending on input constraints. The problem of how much improvement can be expected for a new design becomes exceedingly difficult to measure because of the variables in the data and the problems of quantifying subjective qualitative design features.

Figure 3 shows a typical relationship between MMH/FH and system complexity as a function of R&M program effort. The customer must determine to what level of effort a program will be funded in order to achieve a specified level of maintainability. The degree of technology improvement implemented in a design is bounded by two curves. The upper curve identifies baseline MMH/FH as determined by the model. The lower curve identifies a theoretical or maximum R&M effort that is still cost effective within the program constraints. Somewhere in between is the optimum level of maintainability to be specified by the customer or predicted by the contractor.

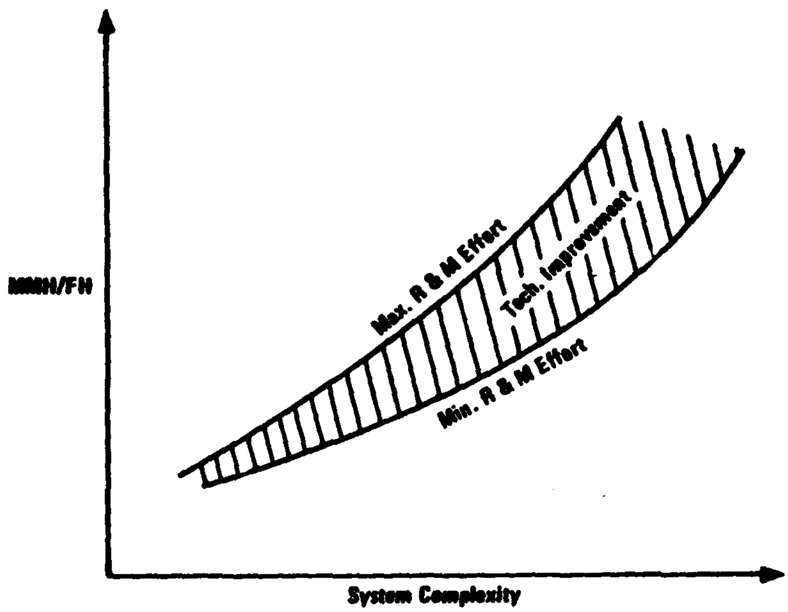


Figure 3. Level of Maintainability Effort

2.5 EQUIPMENT COMMONALITY

A recent report (reference 4) concluded that the most striking characteristic of technology change is its essential continuity across generations of aircraft. The study showed the high commonality of avionics, mission, and support equipment among the A-7, F-4, and F-14 aircraft. Even the newest and most technologically advanced aircraft, the F-14A, was found to have at least 52 percent of its study items incorporated from existing technology on board the A-7 and F-4 aircraft (Table 1). This finding should introduce an element of caution into claims of major manpower reductions for new generations of weapons systems through advanced technology.

TABLE 1. EQUIPMENT COMMONALITY

	A-7B	A-7E	F-4J	F-4N	F-14A
Study Items (165)	71	80	69	64	91
Common to A-7E	55	--	43	43	42
Common to F-4J	38	43	--	63	37
Common to F-14A	34	42	38	36	--
Common to A-7 and F-4	--	--	--	--	47

Source: Reference 3

3.0 SUBSYSTEM DATA ANALYSIS

This section of the study addresses aircraft maintenance data at the three-digit Standard Work Unit Code (SWUC) subsystem level. The intent of this section is to provide supplemental data to support the two-digit SWUC system analysis defined in the MIM and the five-digit WUC component analysis defined in references (5) and (6).

Appropriate historical maintenance data is included in this section to highlight the problem areas of each system. Data is presented in a bar chart format, ranking those subsystems which contribute the most maintenance to each system. It is hoped that by identifying the maintenance significant subsystems of existing aircraft, steps can be taken to correct or minimize future maintenance problems on the next generation of aircraft.

For each system, two sets of bar graphs are presented. The first depicts a subsystem ranking by MMH/FH and MA/FH for a typical aircraft that is most representative of the given system. The second illustration shows average repair time by type aircraft for the high maintenance subsystems. Mean values are presented for both Organizational (O) and Intermediate (I) levels of repair. A brief narrative description commenting on data behavior and qualitative maintainability features is also included. For a more detailed discussion of qualitative maintainability assessment of individual items, see references (1), (5), and (6).

The data base for this study is the same one that was used in the development of the MIM. Raw 3-M data tapes from the 1975/1976 time period were processed by Vought computer routines resulting in a Standard Work Unit Code

Summary Report. Excerpts from this report are presented as Appendices A and B with an aircraft WUC to SWUC Matrix presented in Appendix C.

3.1 SWUC 11/12 AIRFRAME/FUSELAGE SYSTEMS

The Airframe/Fuselage Systems accounts for approximately 9% of the total average unscheduled maintenance man-hours expended on the study aircraft. A typical distribution of Airframe/Fuselage Systems maintenance is shown in Figure 4. The graph, based on A-6E data, shows the Structures Subsystem to have the largest maintenance expenditure with 57% of the man-hours and 49% of the maintenance actions. The Access Doors/Panels Subsystem also is noted as a major contributor because it accounts for an additional 25% of the maintenance actions expended against the system. In all cases the level of maintenance is predominately Organizational. The average repair times for the two major subsystems are illustrated in Figure 5 for the eight study aircraft. On-aircraft (O-level) repair times were generally reasonable except for the AV-8A expenditure in the Structure Subsystem which was twice the mean time of 3.6 hours. Structural repairs to the A-7E and F-14A Wing Outer Panel Skin account for the higher than normal I-level repair times. Repairs to the engine removal door on the A-7E accounts for the 28.0 hours repair time in the Access Doors/Panels Subsystem.

One reason for the high repair time at O-level for the AV-8A Structural Subsystem is the remove and replace requirements for the radome. On the AV-8A aircraft, pitot static lines must be disconnected, several access panels must be removed, and a reaction nozzle must be displaced to allow sufficient clearance for removal. The physical size of the radome by necessity adds to the Elapsed Maintenance Time per Maintenance Action and number of personnel required.

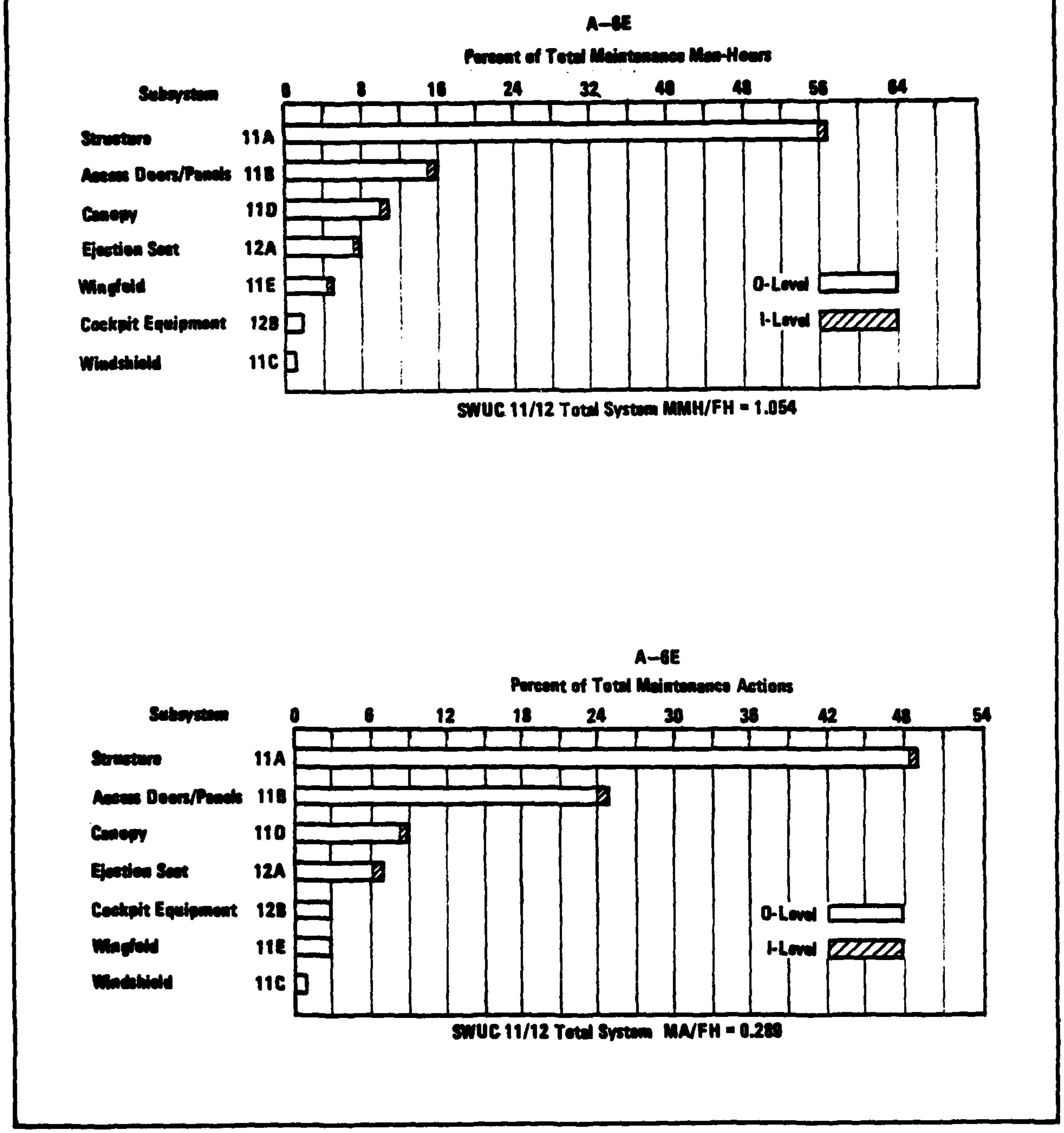


Figure 4. Distribution of A–6E Airframe/Fuselage Systems Maintenance (SWUC 11/12)

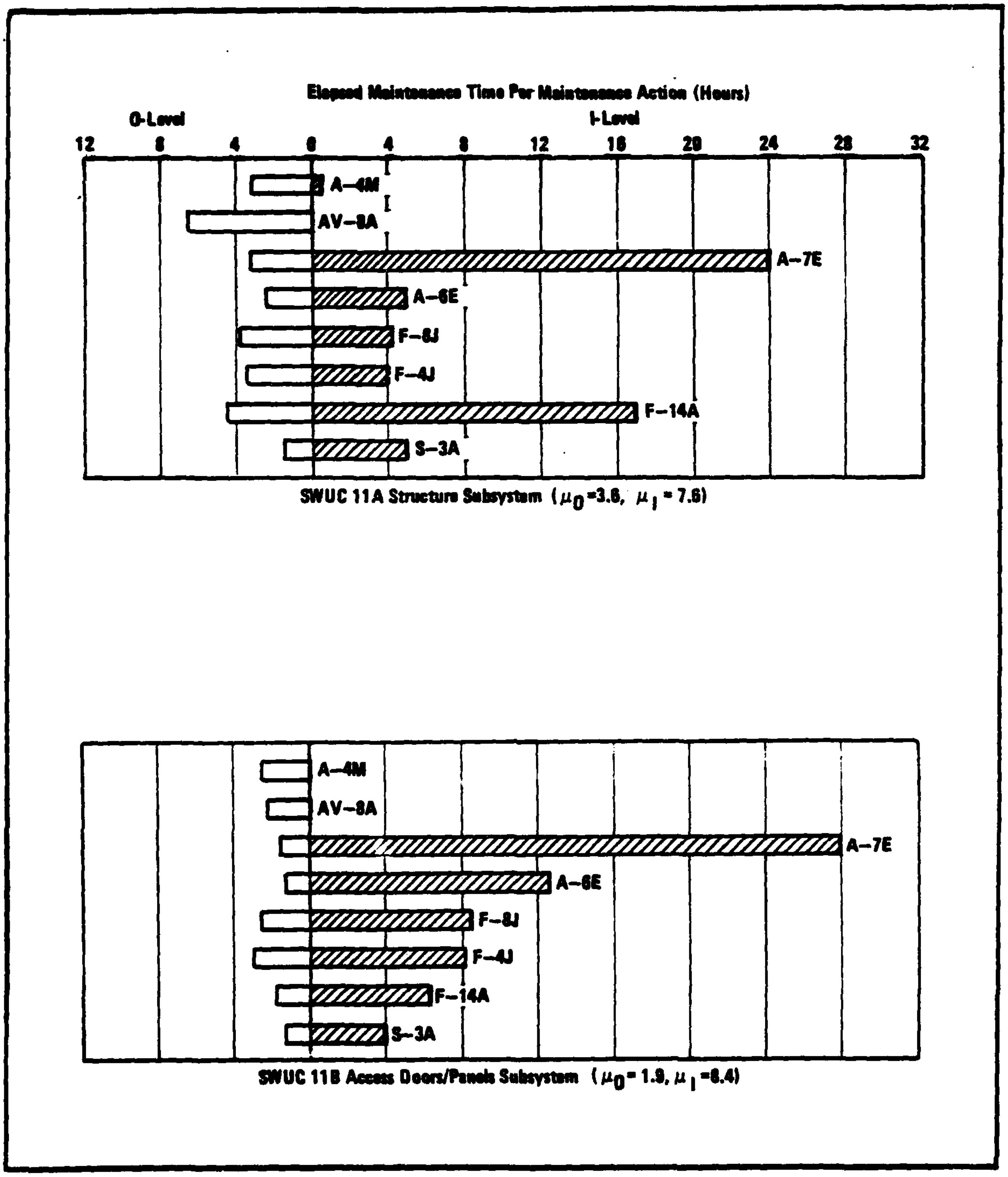


Figure 5. Average Repair Time for Major Airframe/Fuselage Subsystems (SWUC 11/12)

3.2 SWUC 13 LANDING GEAR SYSTEM

The Landing Gear System accounts for about 10% of an aircraft's unscheduled maintenance expenditure as measured in MMH/FH. Figure 6 shows a typical distribution of Landing Gear System maintenance using F-14A data. Within this system, the Wheel/Tire Assembly, Main Landing Gear (MLG) and Doors Subsystem and the Brake Subsystem account for 67% of the manhours expended and 74% of the maintenance actions reported.

The majority of the F-14A Wheel/Tire Assembly maintenance is done at I-level where an average repair time of 3.8 hours is almost twice the mean value for all eight aircraft as shown in Figure 7. On-aircraft repair for most aircraft is less than one hour but ranges from 1.1 to 3.8 hours at I-level. Similar distributions of repair time at O and I-levels for the MLG and Doors Subsystem and the Brake Subsystem show wide ranges in average repair time.

The degree of technology improvement predicted in a new aircraft's Landing Gear System should be a function of the R&M effort made in the above three subsystems.

A positive maintainability feature noted during the study was in the Main Landing Gear Wheel and Tire Subsystem on the S-3A aircraft. A special bolt is used, which when tightened, keeps the brake discs aligned while the tire is off. This feature eliminates one of the time consuming installation steps - brake disc alignment. This is a prominent contributing factor to the low average Elapsed Maintenance Time per Maintenance Action shown in Figure 7 (SWUC 13C for O-level maintenance) on the S-3A aircraft.

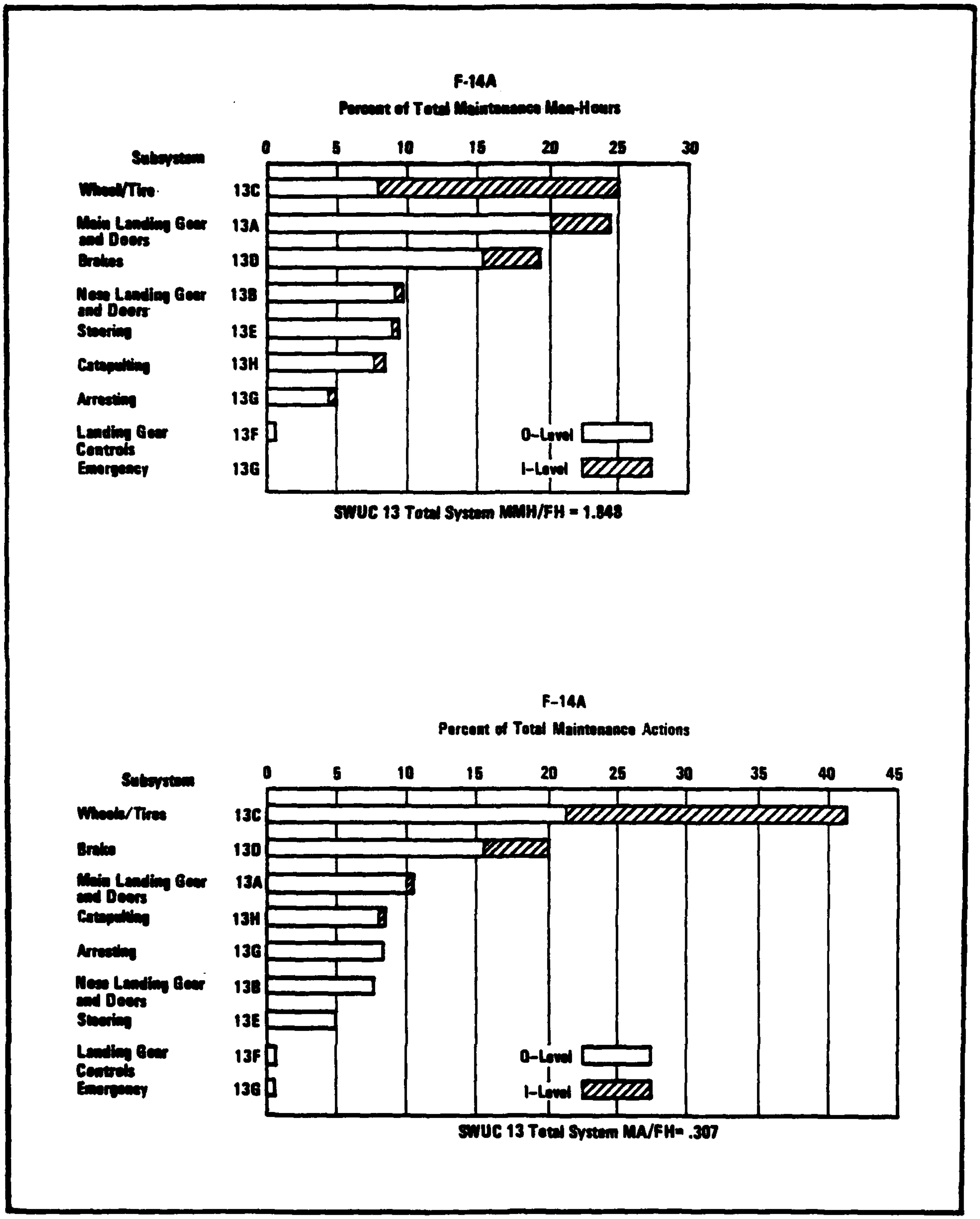


Figure 6. Distribution of F–14A Landing Gear System Maintenance (SWUC 13)

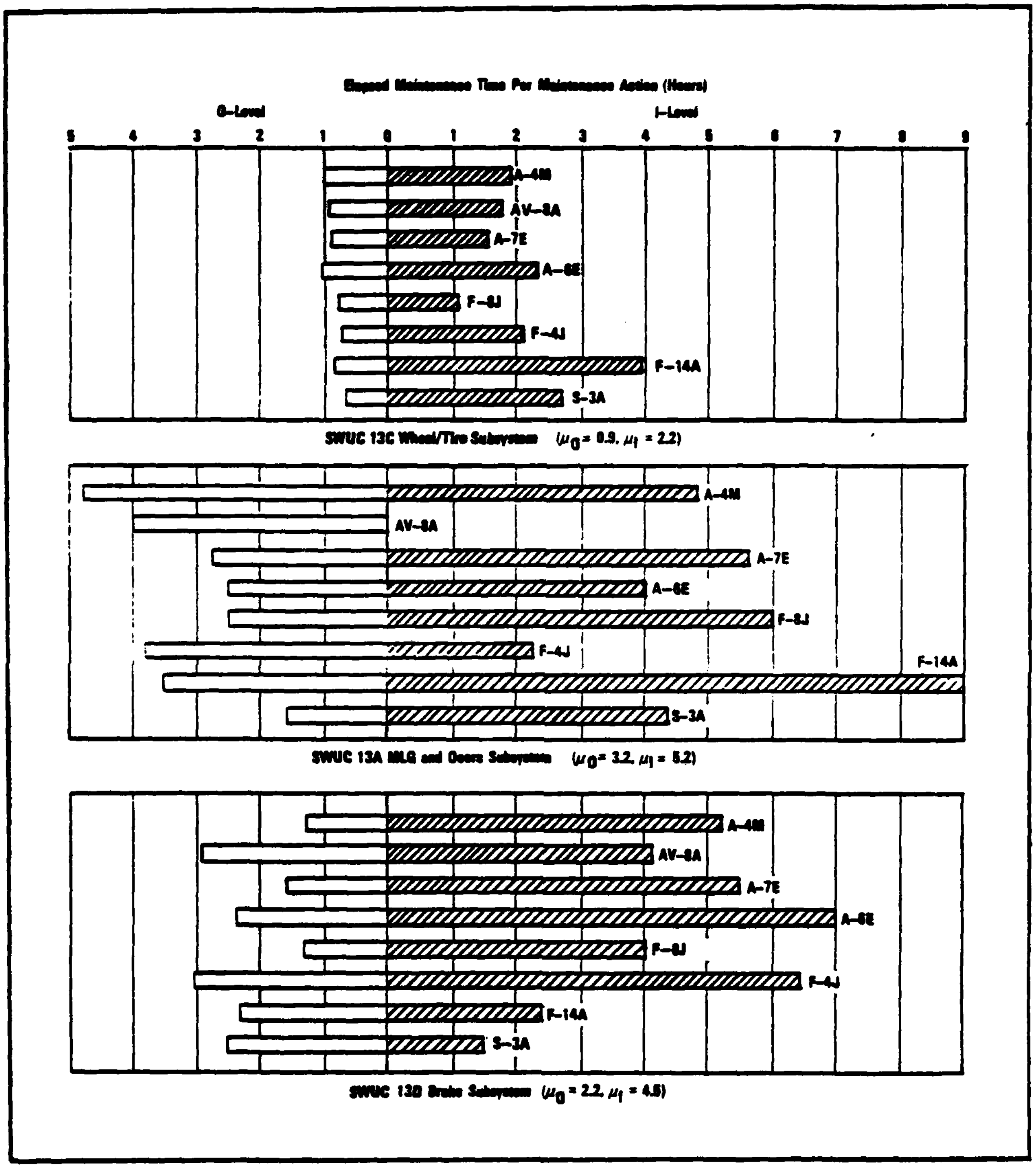


Figure 7. Average Repair Time of Major Landing Gear Subsystems (SWUC 13)

A negative maintainability feature noted in the Brake Subsystem was the use of shims and sealant during installation of the brake on the F-4J aircraft. As noted in Figure 7 (SWUC 13D), the average elapsed maintenance time for O-level maintenance is the highest of all study aircraft.

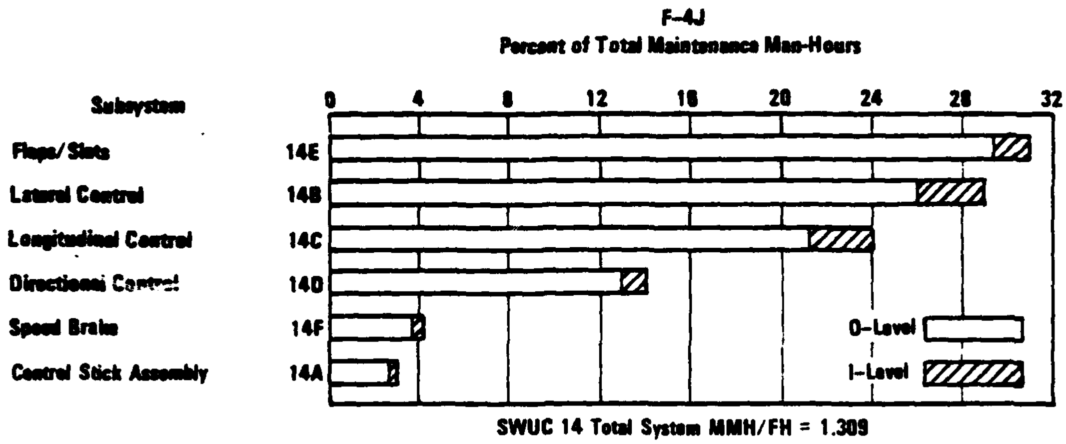
An installation utilizing a tripod type main landing gear design appear to be less costly to maintain. For example, the use of this type installation allows for removal and replacement of components such as a shock strut without removal of the wheels and tires. In addition; the use of tripod gears requires a smaller and lighter shock strut.

3.3 SWUC 14 FLIGHT CONTROLS SYSTEM

The Flight Controls System contributes about 7% of the total average unscheduled maintenance time expended on the eight study aircraft.

The maintenance distribution of the Flight Controls System is presented in Figure 8 using F-4J data as the representative aircraft. Three of these subsystems, Flaps/Slats, Lateral Control, and Longitudinal Control, account for 84% of the man-hours and 80% of the maintenance actions reported against the system.

Figure 9 depicts the average repair times for the three subsystems for each of the eight study aircraft. The F-4J falls close to the mean time for each of the subsystems and represents an almost even distribution of O and I-level maintenance time. This is not the case with the F-14A which depicts an average repair time of twice the mean time for the Lateral Control Subsystems in both I and O-level maintenance. Similar excursions are noted for the other subsystems and for other aircraft.



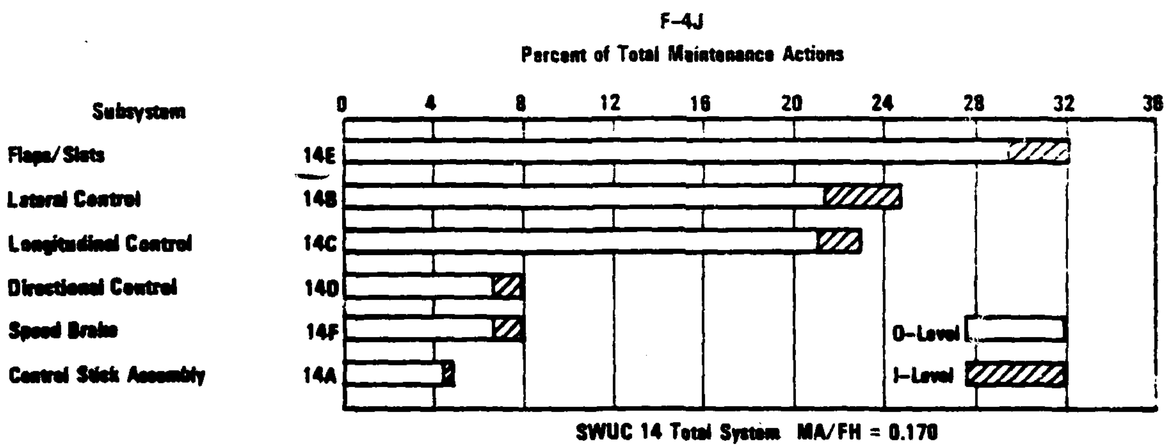


Figure 8. Distribution of F-4J Flight Controls System Maintenance (SWUC 14)

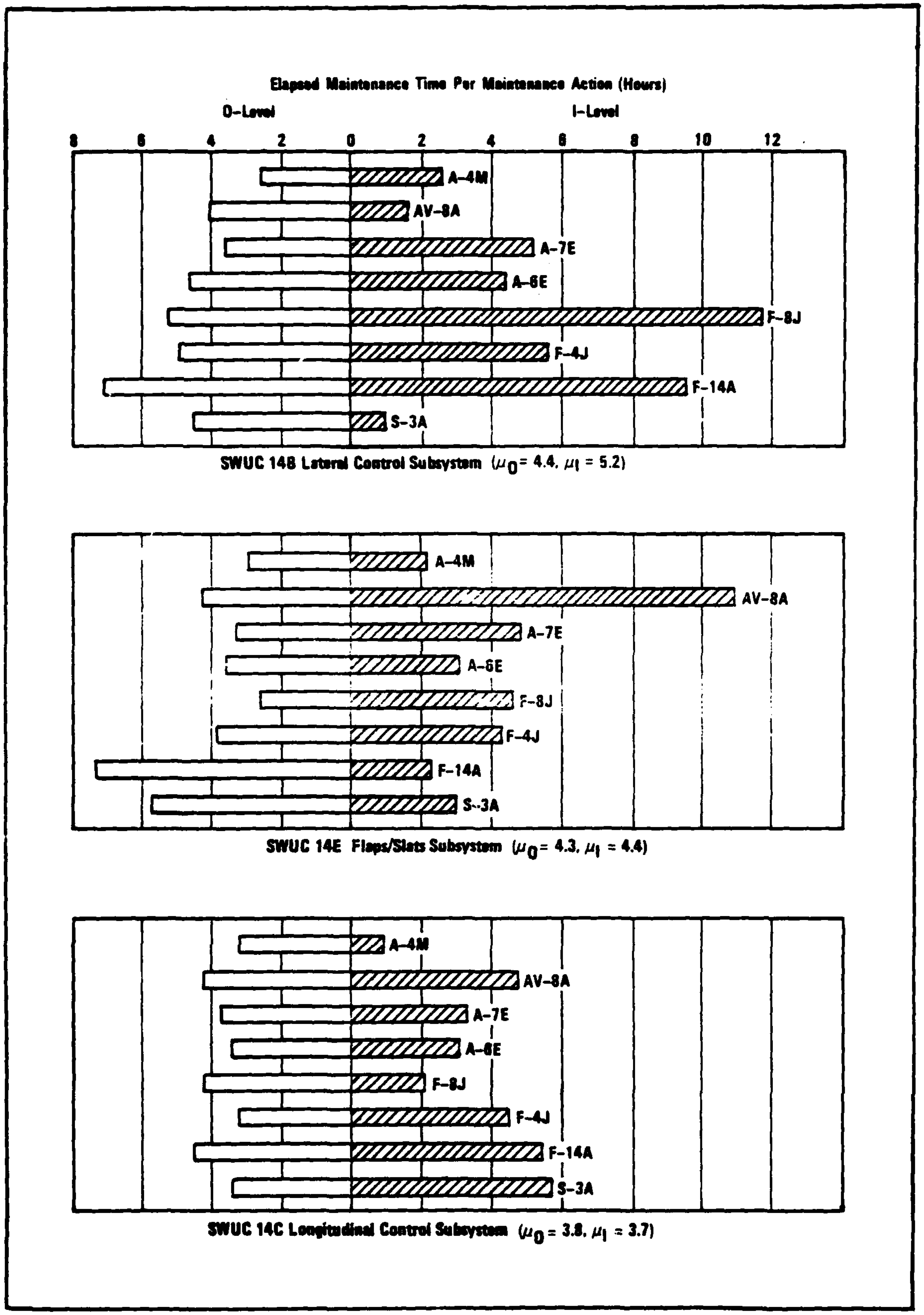


Figure 9. Average Repair Time for Major Flight Controls Subsystems (SWUC 14)

Negative maintainability features noted in the Flight Controls System were inadequate hand/tool room for repair action, requirements for rigging after repair, and the number of fastener removals required for access.

3.4 SWUC 23 ENGINE SYSTEM

The Engine System averages about 9% of the unscheduled maintenance generated by the eight study aircraft. Figure 10 presents a typical distribution of Engine System maintenance using S-3A data. The distribution indicates the basic Engine and the Main/AB Fuel subsystem to be the two major engine subsystems accounting for 85% of the man-hours and 68% of the maintenance actions expended.

The average repair times for the two major subsystems are presented in Figure 11 for comparison of expenditures between the eight study aircraft. The average repair times for the Basic Engine System are at 8.4 and 7.9 hours for O and I-levels respectively. Organizational level repair time is primarily a function of engine removal and replacement time. As a typical aircraft, the S-3A falls within the mean limits, but the F-14A sets the maximum I-level expenditure of 12.4 hours and the A-7E shows a 12.6 hour rate for O-level maintenance. Similar distributions are shown for the Main/AB Fuel Subsystem although lesser in magnitude and more predominantly O-level expenditures.

3.5 SWUC 29 POWER PLANT INSTALLATION SYSTEM

Only about 2% of the total average unscheduled maintenance time is attributed to the Power Plant Installation System. Using A-6E data, Figure 12 was derived to show a typical distribution of Power Plant Installation System maintenance. The data shows the Exhaust Subsystem and Power Plant Controls Subsystems accounted for 84% of the man-hours and 74% of the maintenance actions reported against the system.

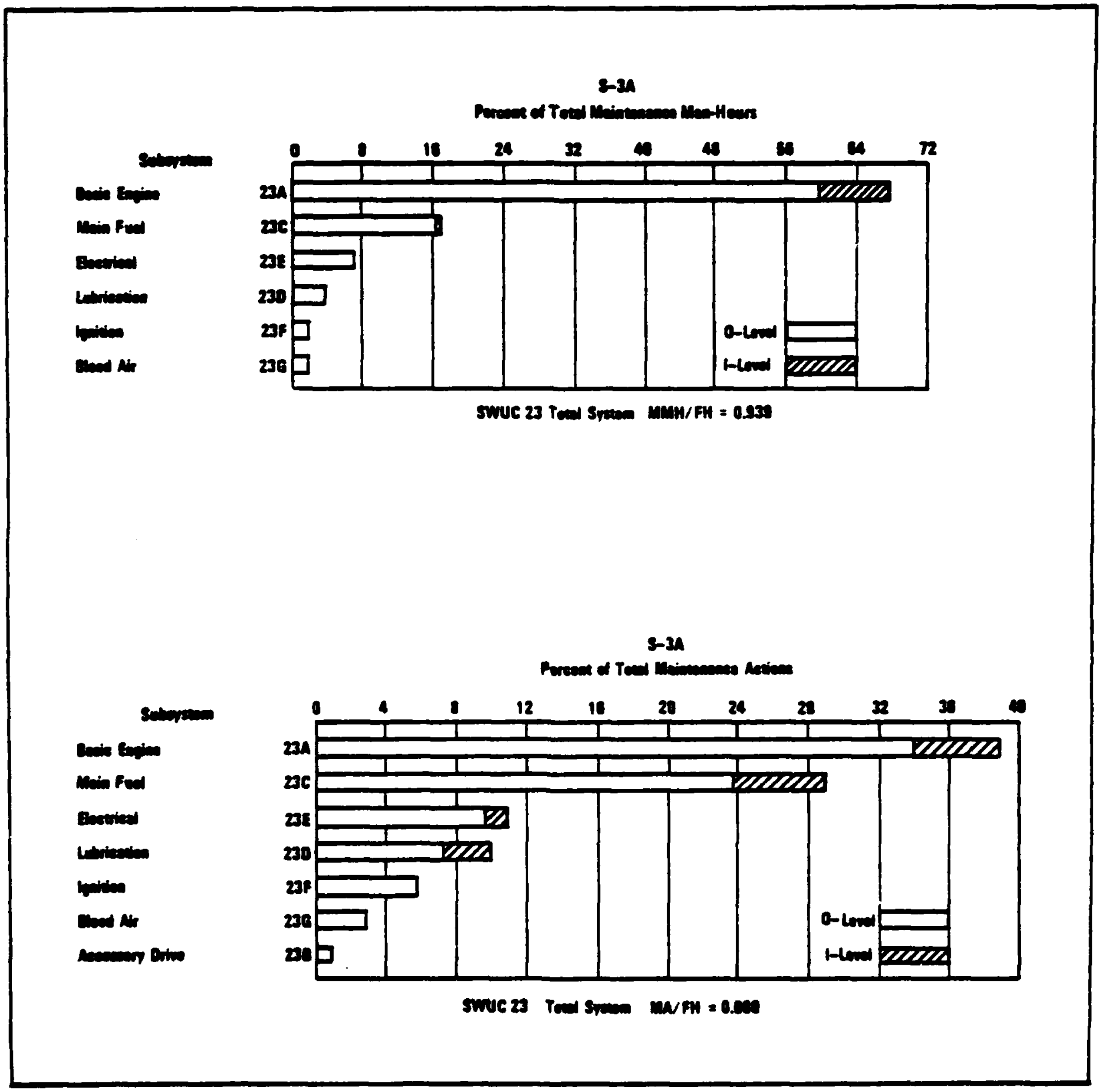


Figure 10. Distribution of S-3A Engine System Maintenance (SWUC 23)

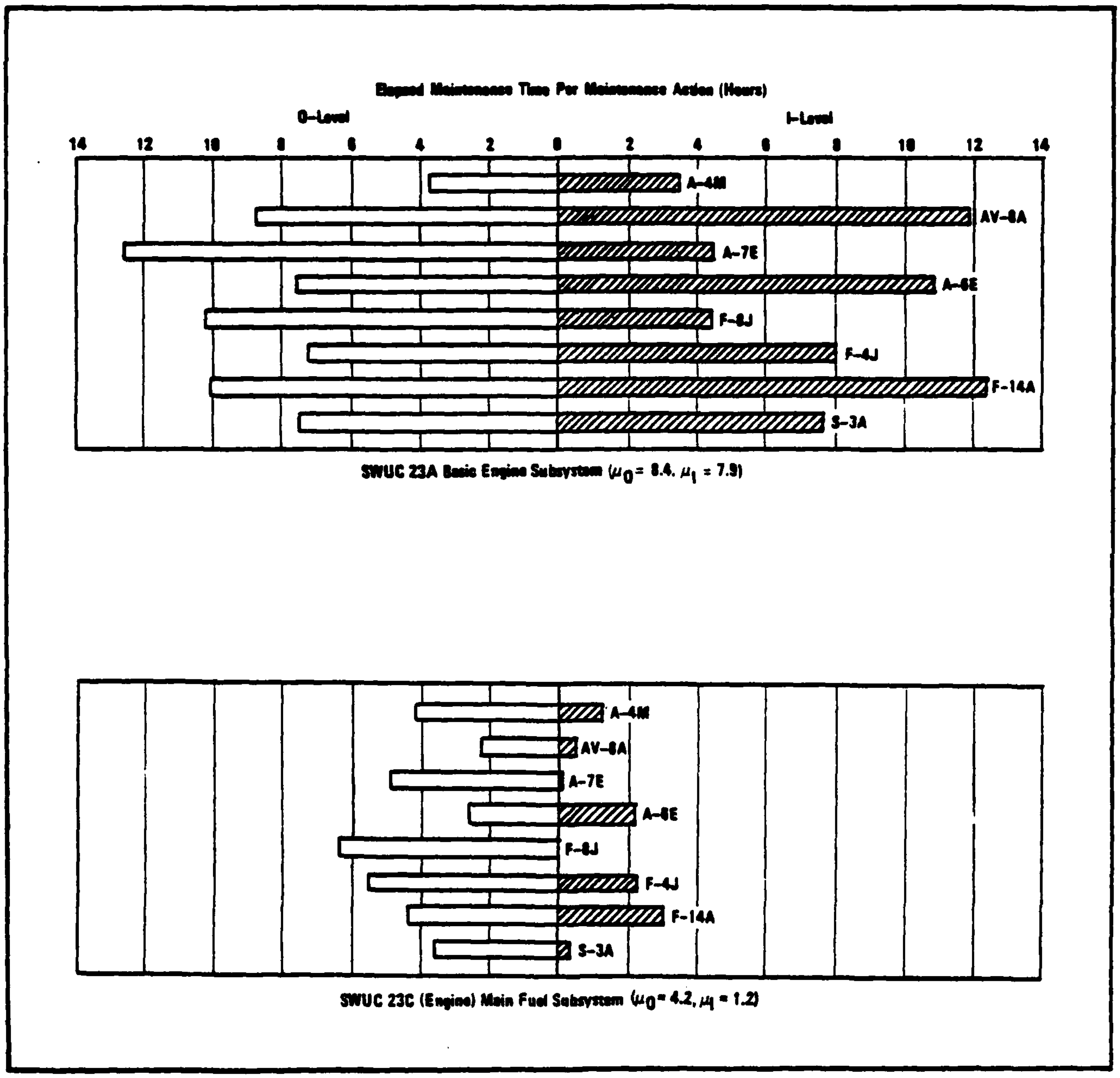


Figure 11. Average Repair Time for Major Engine Subsystems (SWUC 23)

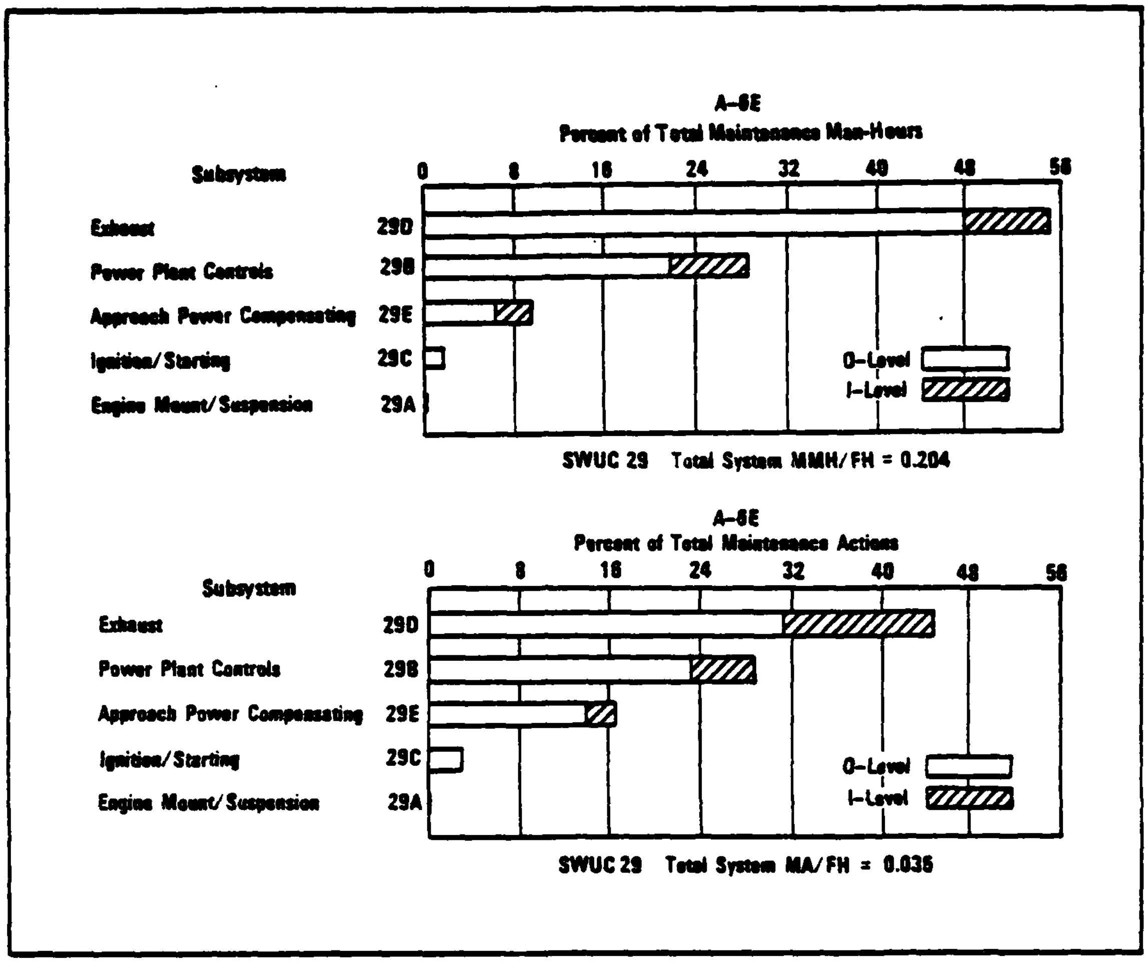


Figure 12. Distribution of A-6E Power Plant Installation System Maintenance (SWUC 29)

The majority of the A-6E Exhaust Subsystem maintenance is performed on-aircraft where an average repair time of 3.6 hours is almost 28% greater than the mean time for all the reporting aircraft as shown in Figure 13. At I-level the A-6E repair time is equivalent to the mean of 2.5 hours where I-level repair ranges from 1.2 to 6.6 hours. Similar O and I-level mean times are noted for the Power Plant Controls Subsystem with a comparable range of repair times.

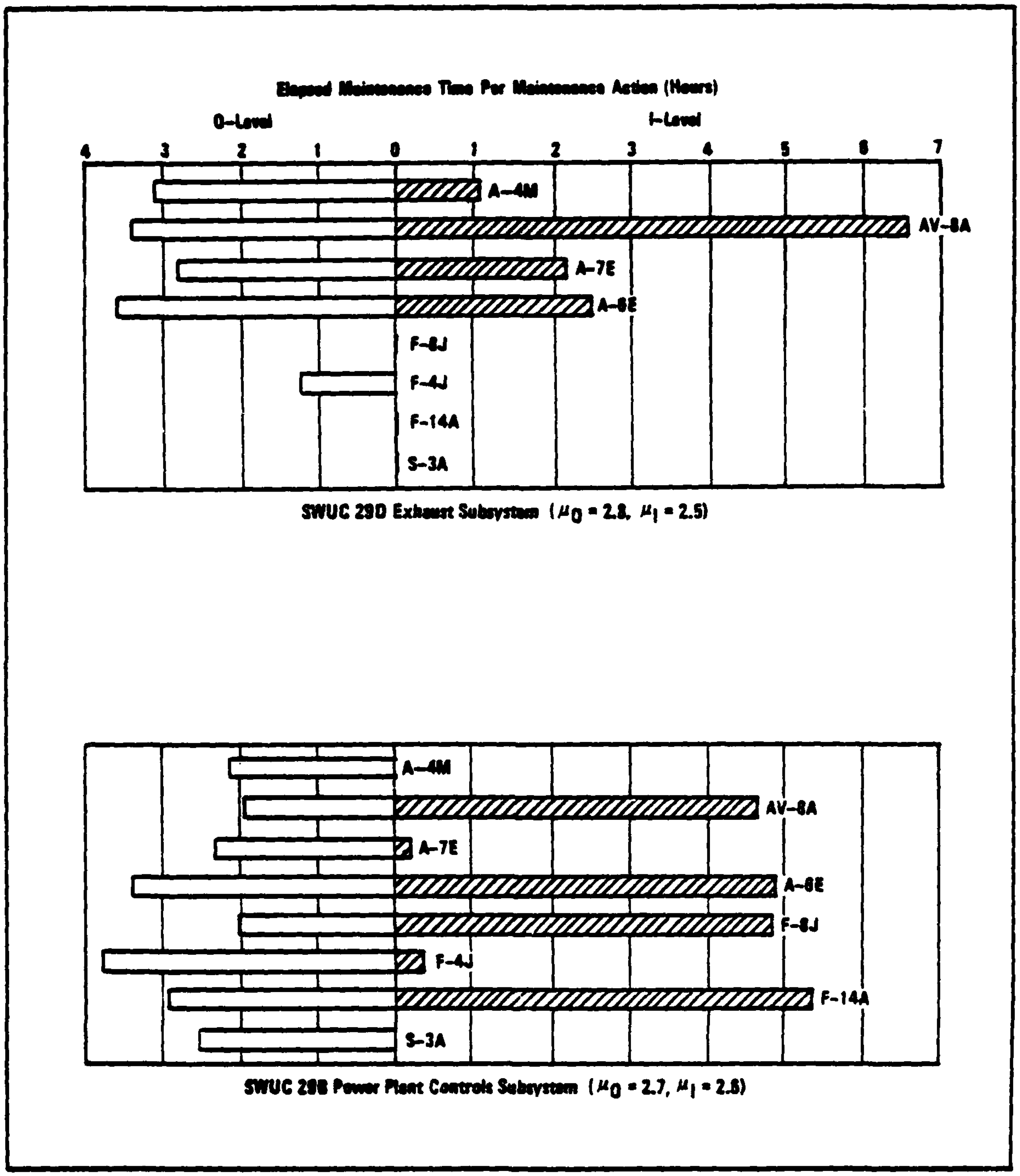


Figure 13. Average Repair Time for Major Power Plant Installation Subsystems (SWUC 29)

3.6 SWUC 41 AIR CONDITIONING SYSTEM

On the average about 2% of the total unscheduled maintenance time expended on each of the study aircraft was attributed to the Air Conditioning System. Figure 14 shows a typical distribution of Air Conditioning System maintenance using F-14A data. Within this system the Air Conditioning and Pressurization Subsystems account for 66% of the man-hours expended and 61% of the maintenance actions reported.

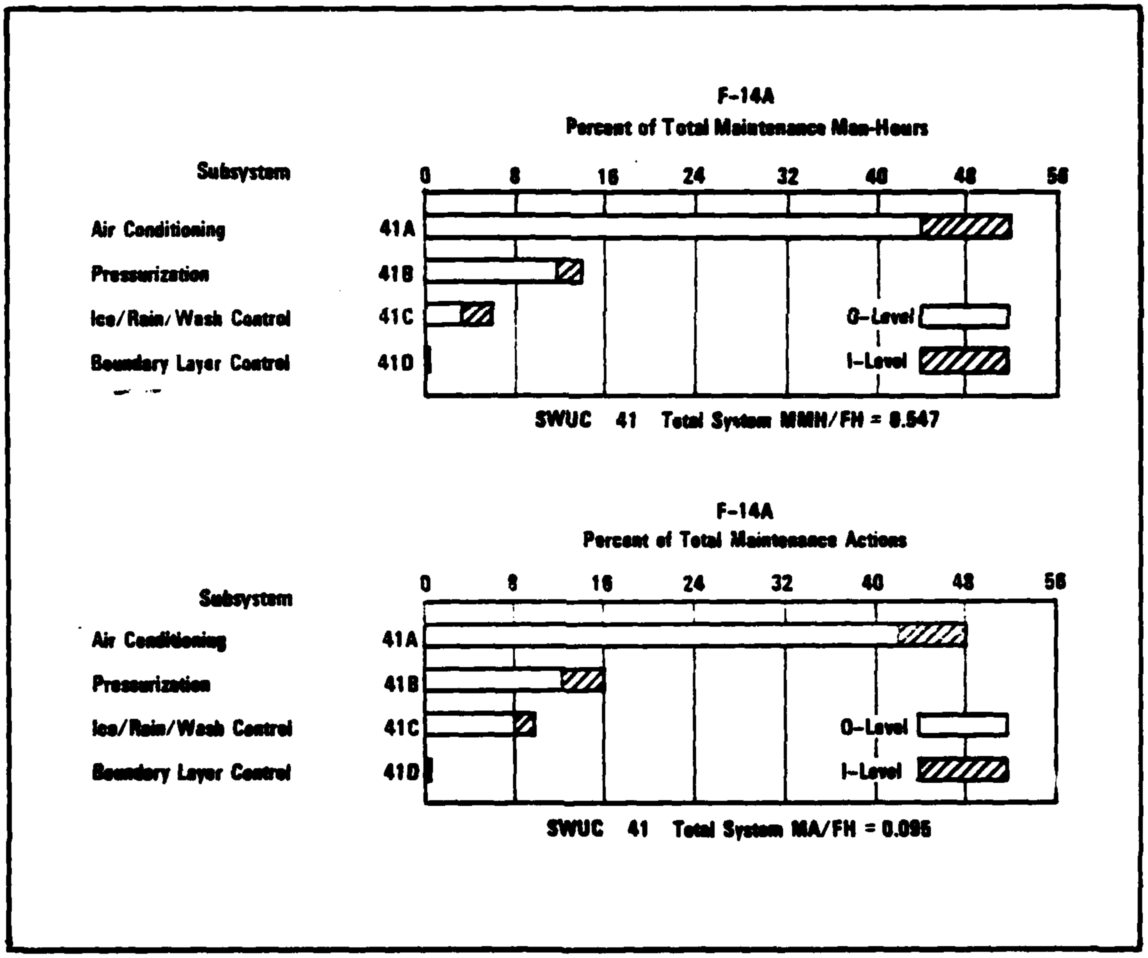


Figure 14. Distribution of F–14A Air Conditioning System Maintenance (SWUC 41)

The majority of the F-14A Air Conditioning Subystem maintenance is done at O-level where an average repair time of 3.5 hours is slightly over the mean value of all eight study aircraft as shown in Figure 15. The I-level repair times range from 0.6 to 2.8 hours with the F-14A showing an average repair time slightly more than half the mean value of 1.7 hours. Similar distribution of repair times are shown for the Pressurization Subsystem at O and I-levels with a wider distribution of repair times from 0.5 to 5.6 hours noted in the I-level expenditures.

A negative maintainability feature noted in this system during the study was the maintenance requirements for the AV-8A Temperature Controller which has hard-wired switches. Maintenance on these switches requires unsoldering, soldering, unpotting, and potting electrical connections in the cockpit or cutting and later splicing wires. These requirements are not only undesirable, they also are very time consuming (see Figure 15, SWUC 41A, O-level for the AV-8A aircraft).

3.7 SWUC 42 ELECTRICAL SYSTEM

The unscheduled maintenance expenditures attributed to the Electrical System amounts to about 6% of the total average time expended on each of the study aircraft. Data from the F-4J was used to produce the typical distribution of Electrical System maintenance shown in Figure 16. Within this system the AC Power Supply and Aircraft Wiring Subsystems account for 73% of the man-hours expended and 72% of the maintenance actions reported.

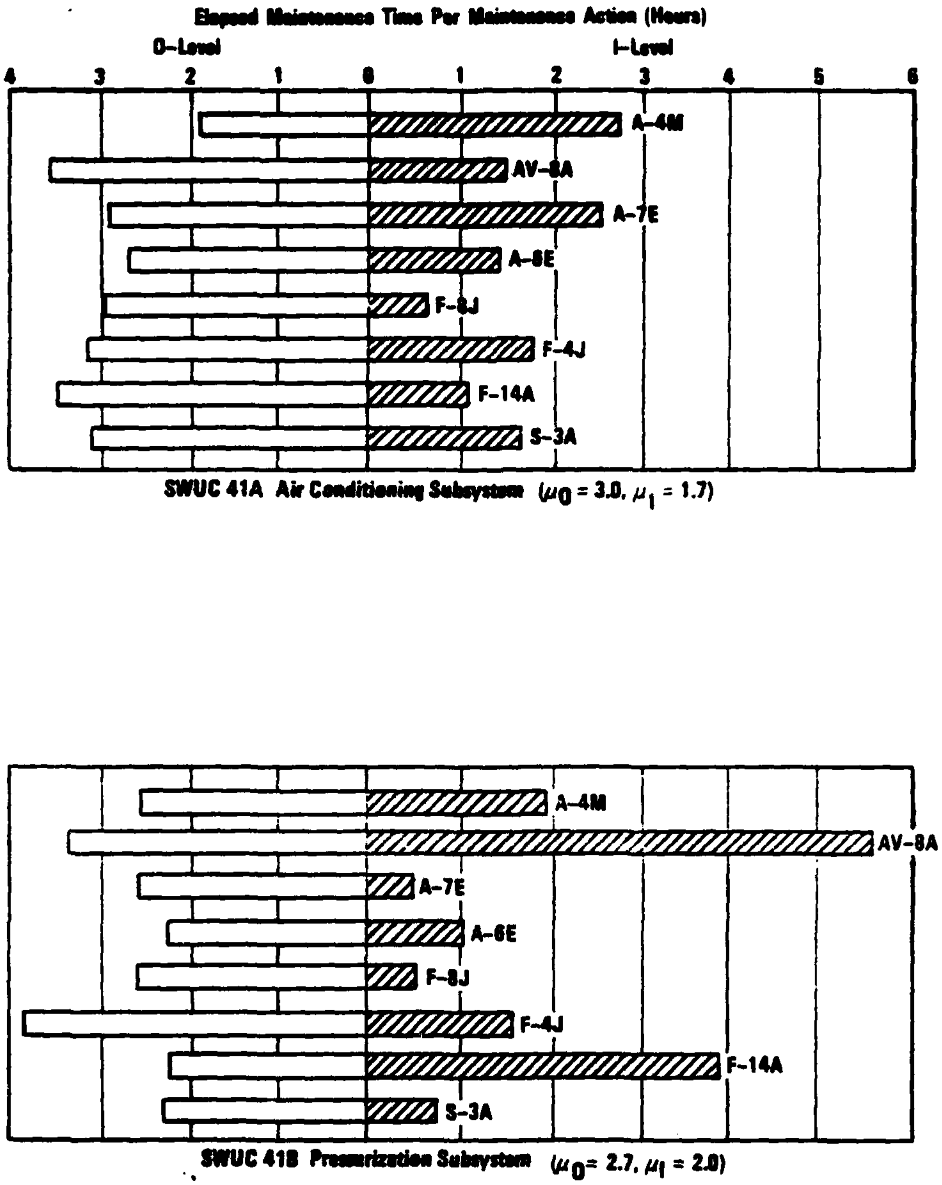


Figure 15. Average Repair Time for Major Air Conditioning Subsystems (SWUC 41)

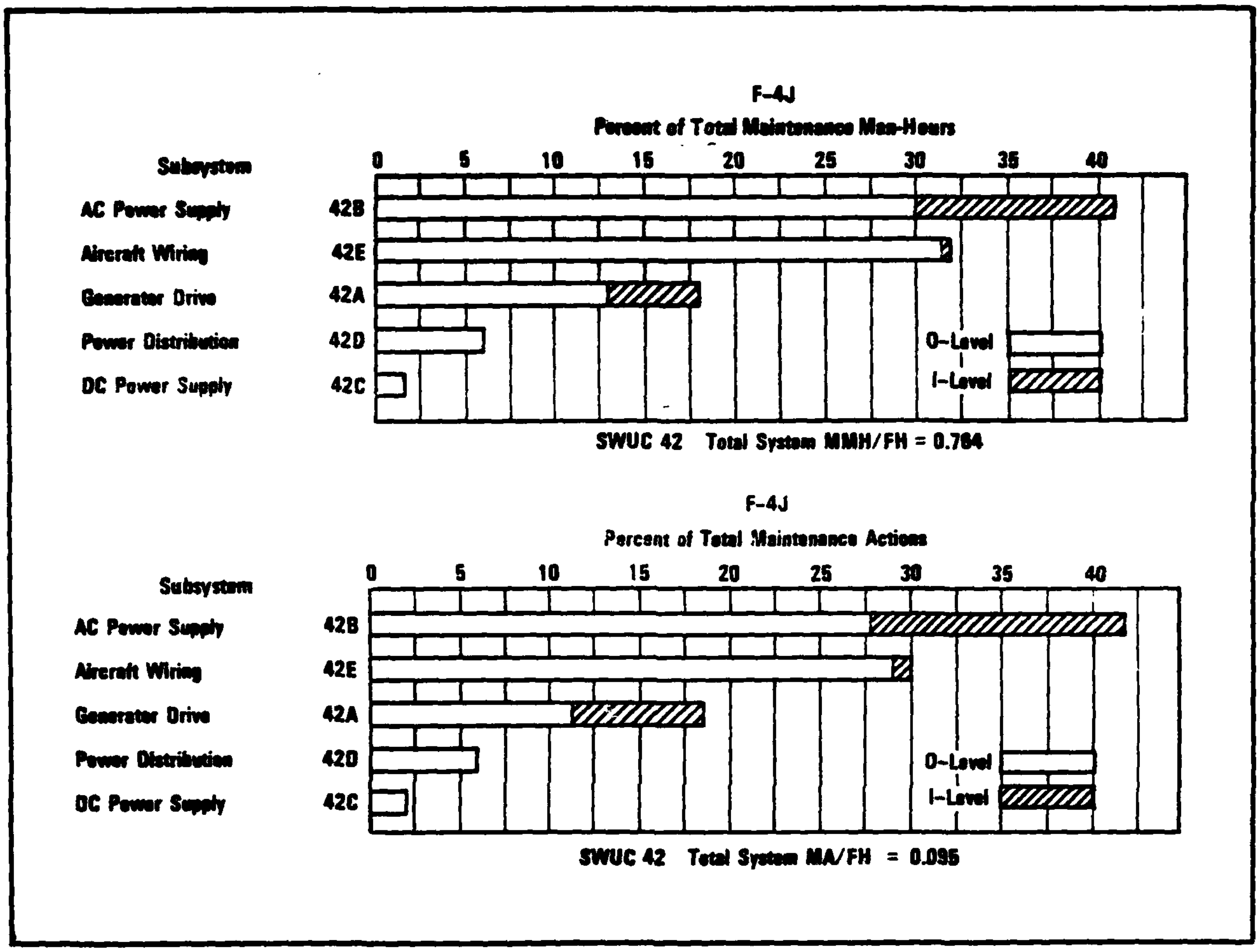


Figure 16. Distribution of F-4J Electrical System Maintenance (SWUC 42)

Figure 17 depicts the average repair times for the three major subsystems for each of the study aircraft. For the AC Power Supply Subsystem the F-4J represents an almost even distribution of maintenance level repair times with an expenditure of about 1.2 hours over the mean value. Repair actions against the Generator Regulator Panel and Generator are the contributing factors. For the aircraft Wiring Subsystem the I-level repair time for the F-4J is over three times the mean value and represents the widest excursion within the

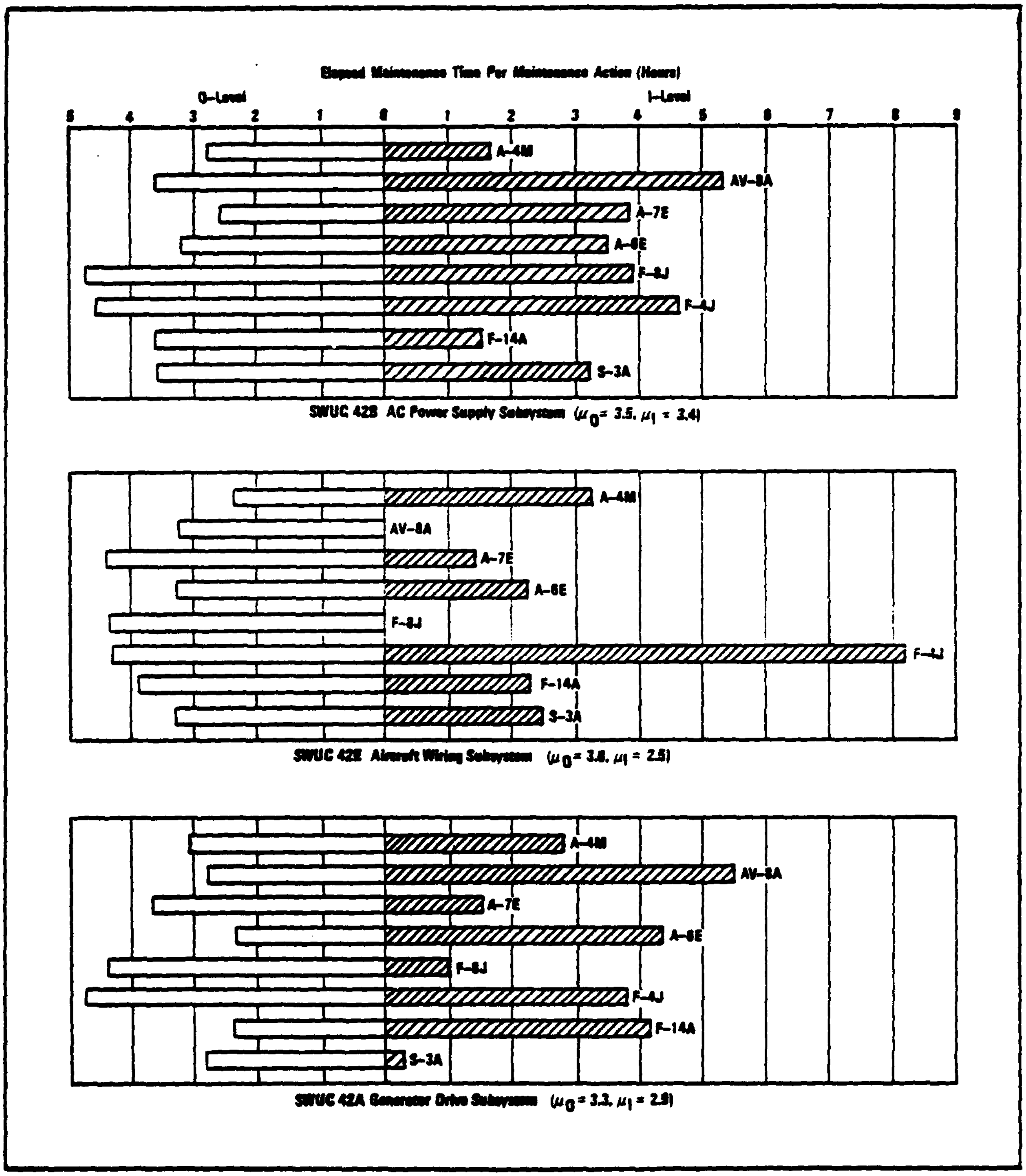


Figure 17. Average Repair Time for Major Electrical Subsystems (SWUC 42)

study aircraft. Anomalies related to the wiring circuits for the Fire Detection, Exterior Lighting, and Engine Start Subsystems are the drivers in repair time. A closer time distribution is noted in O-level. Similar repair time distribution is shown for the Generator Drive Subsystem.

A negative maintainability requirement noted in the Electrical System was the requirement, in many instances, for an engine run to operationally check a component after installation. For example, after removal and replacement of the Generator Control Panel on the F-8J aircraft, an engine run is required to operationally check the Electrical System. This requirement has an influence on the Elapsed Maintenance Time per Maintenance Action (see Figure 17, SWUC 42B, O-level).

3.8 SWUC 44 LIGHTING SYSTEM

The Lighting System contributes about 2% of the unscheduled maintenance time expended on each of the study aircraft. F-8J data was used to show a typical distribution of Lighting System maintenance (Figure 18).

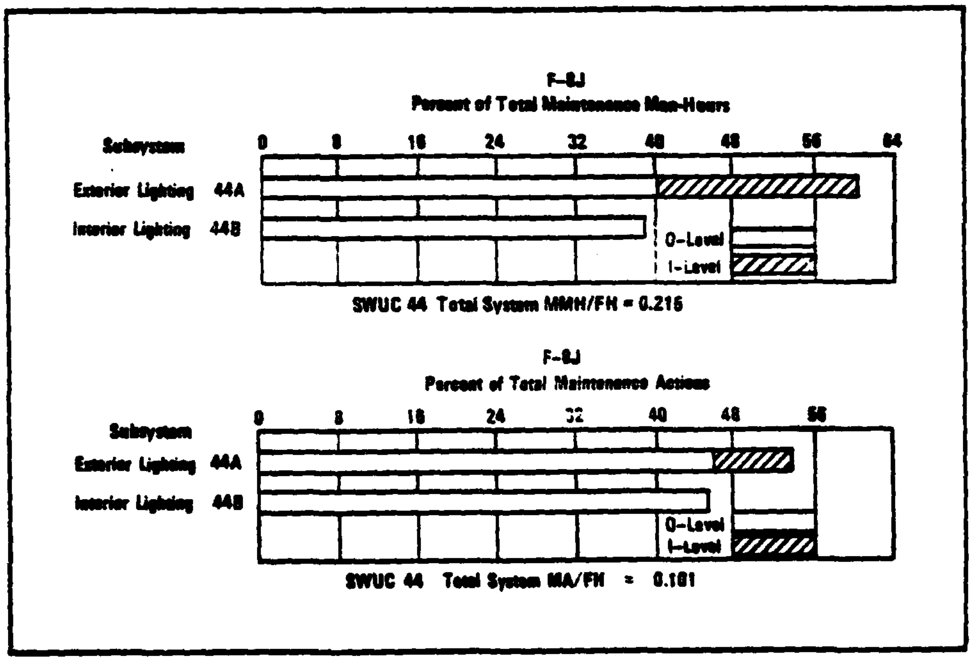


Figure 18. Distribution of F-8J Lighting System Maintenance (SWUC 44)

This system is comprised of two subsystems, Exterior and Interior Lighting, with the Exterior Subsystem accounting for 61% of the man-hours expended and 54% of the maintenance actions reported. The majority of the F-8J Exterior Lighting maintenance is performed at I-level where an average repair time of 3.7 hours is substantially over the mean value of 2.9 hours for all eight study aircraft shown in Figure 19. On-aircraft repair times range from 1.1 to 1.7 hours resulting in a mean of 1.3 hours which corresponds to the repair time for the typical aircraft. Similar distributions are noted for the Interior Lighting Subsystem for both maintenance levels. The mean repair time for the I-level is 3.6 hours because of a large increase in expenditures on the F-14A.

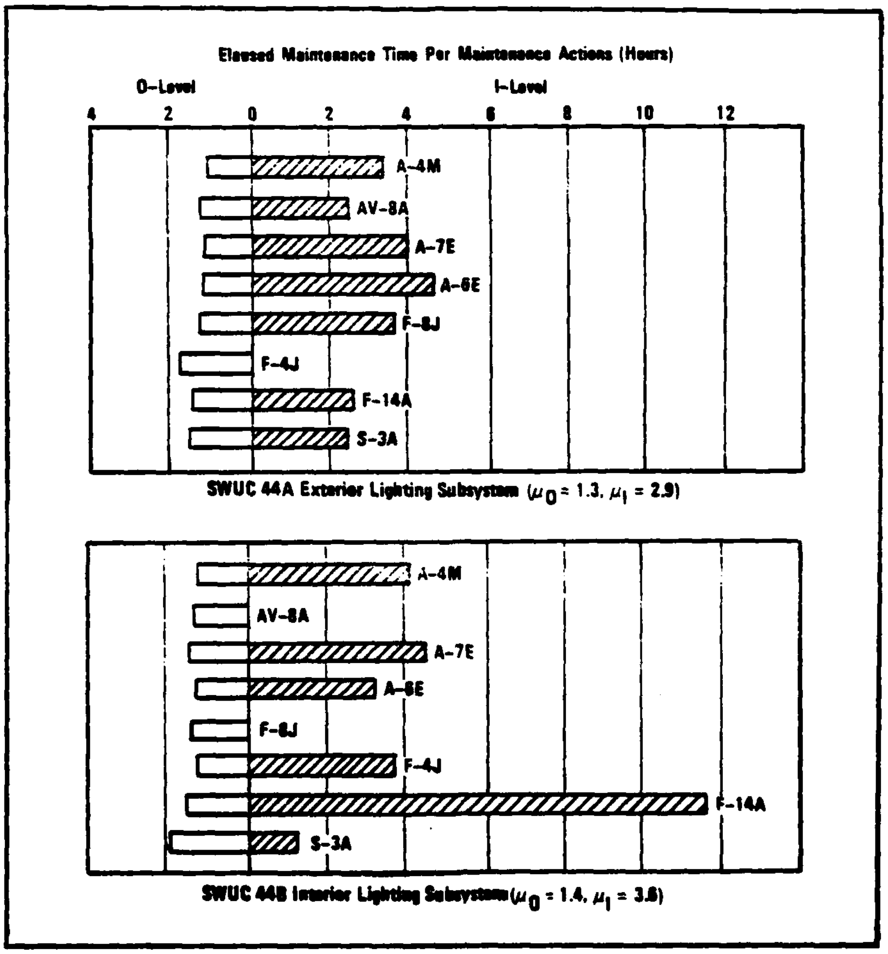


Figure 19. Average Repair Time for Major Lighting Subsystems (SWUC 44)

The negative maintainability features noted in this system were primarily the requirement to remove panels which have numerous screws to gain repair access. For example, to repair the Tail Position Lights on the F-4J aircraft an access panel with 40 screws must be removed. Support for this type design is what drives the Elapsed Maintenance Time per Maintenance Action (see Figure 19, SWUC 44A, O-level for the F-4J aircraft).

3.9 SWUC 45 HYDRAULIC SYSTEM

The Hydraulic System was found to contribute only about 3% of the unscheduled maintenance time expended on the study aircraft. A typical distribution of Hydraulic System maintenance is shown in Figure 20. The graph, based on A-7E data, shows that the Normal Hydraulic Subsystem accounts for the largest maintenance expenditure with 73% of the man-hours and 74% of the maintenance actions reported.

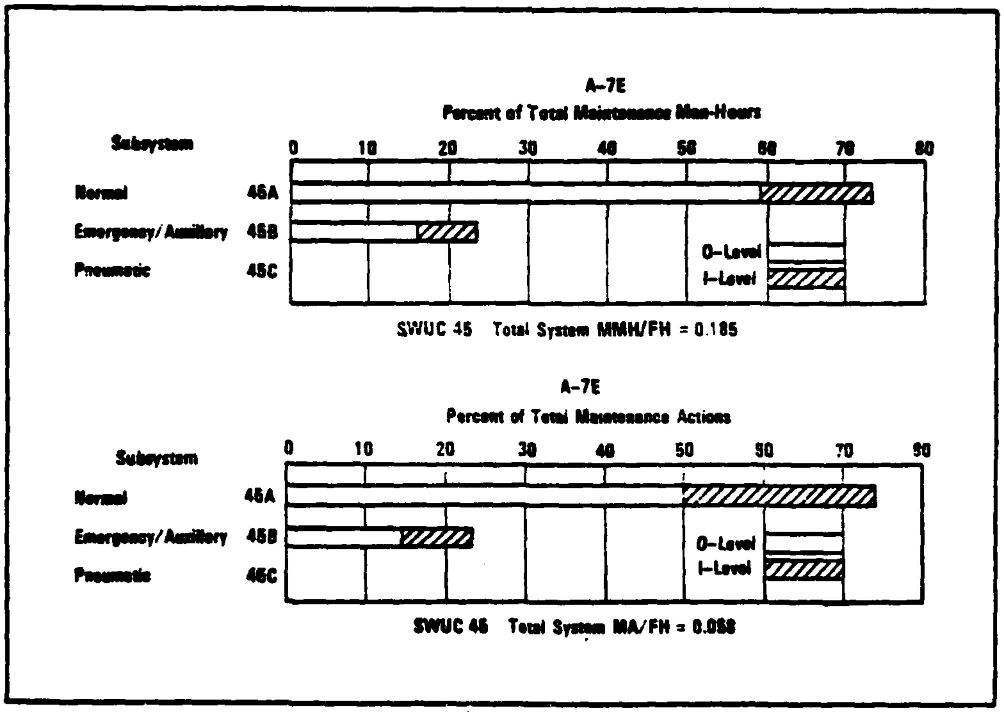


Figure 20. Distribution of A-7E Hydraulic System Maintenance (SWUC 45)

In Figure 21 the average repair times for the major subsystems is presented for the eight study aircraft. The A-7E shows the least repair time expenditure and averages 40% less time than the mean time of 3.1 and 3.2 expended by the eight aircraft for O and I-levels respectively. On-aircraft repair times range from 2.1 to 3.9 hours while the I-level, because of an extreme repair time expenditure for the F-14A ranges from 1.8 to 8.3 hours.

The high Elapsed Maintenance Time at O-level for the AV-8A aircraft is influenced by the requirement to remove the Wing to gain access to the Hydraulic Reservoir for adjustment and/or repairs (see Figure 21, SWUC 45B).

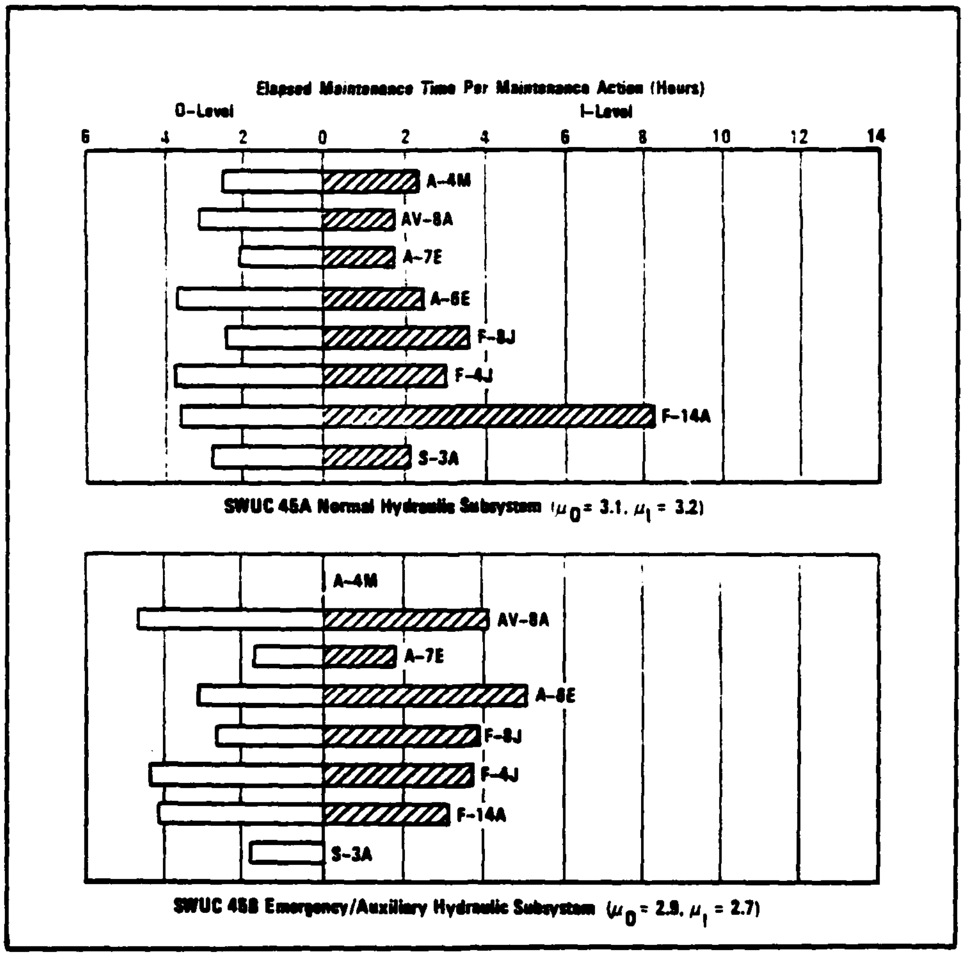


Figure 21. Average Repair Time for Major Hydraulic Subsystems (SWUC 45)

3.10 SWUC 46 FUEL SYSTEM

About 3% of the unscheduled maintenance expended on the eight study aircraft was attributed to the Fuel System. Figure 22 shows a typical distribution of Fuel System maintenance using A-6E data. It indicates that the Internal Fuel Subsystem is the major contributor accounting for 67% of the man-hours expended and 57% of the maintenance actions reported.

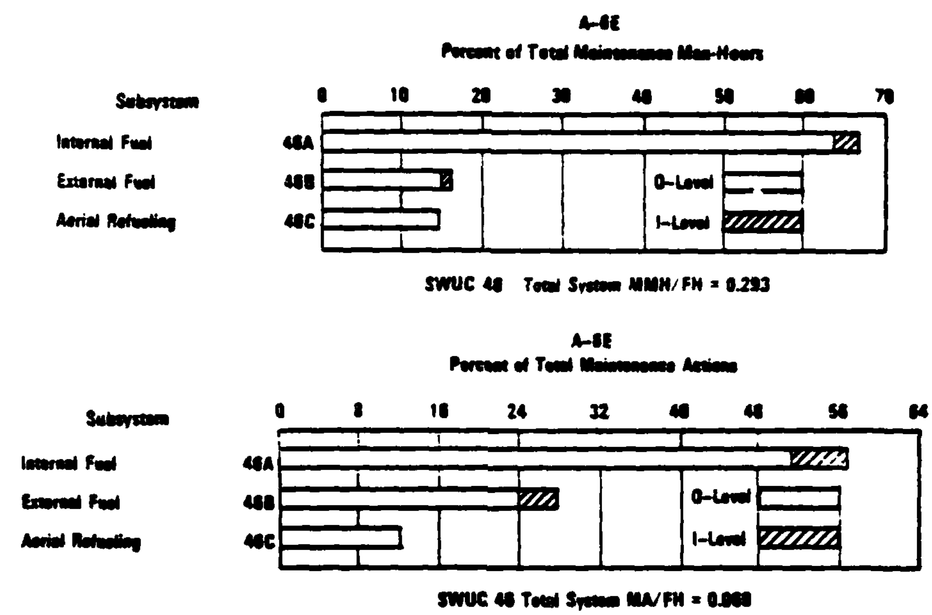


Figure 22. Distribution of A-6E Fuel System Maintenance (SWUC 46)

A comparison plot is shown in Figure 23 for the average repair time expended on the Internal Fuel Subsystem for each of eight study aircraft. The majority of the repair time is performed at O-level with the A-6E reporting an expenditure of 2.8 hours. This is substantialy less than the mean value of 4.1 hours for the reporting aircraft which range from 2.3 to 7.0 hours. A similar distribution of lesser magnitude is noted at I-level where a mean repair time of 1.2 hours was noted based on a range of 0 to 2.7 hours.

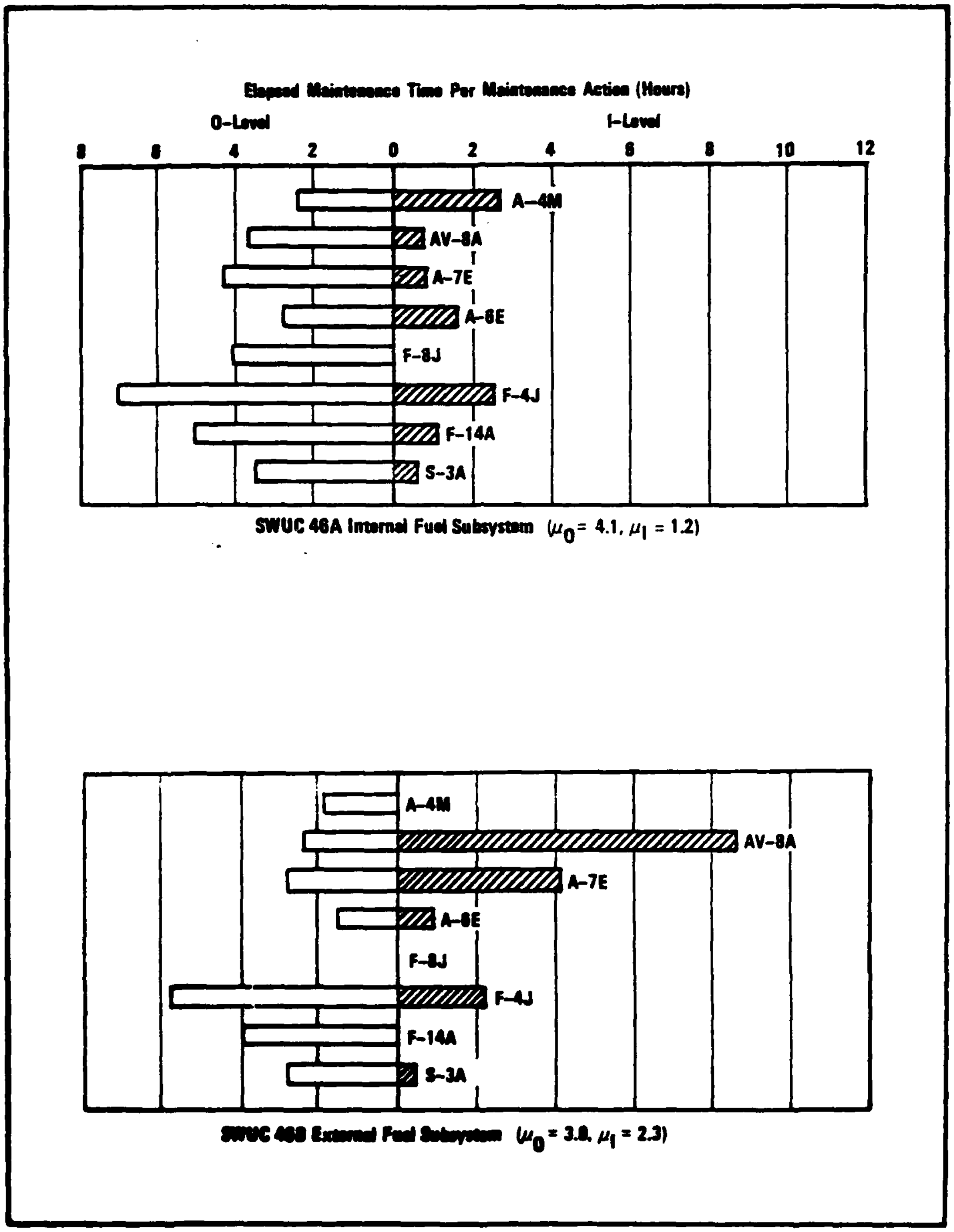


Figure 23. Average Repair Time for Major Fuel Subsystems (SWUC 46)

3.11 SWUC 49 MISCELLANEOUS UTILITIES SYSTEM

As an unscheduled maintenance time contributor the Miscellaneous Utilities System accounts for less than 1% of the total time attributed to each of the study aircraft. In Figure 24 a typical distribution of Miscellaneous Utilities System maintenance is presented based on F-14A data. Within this system, Fire Detection Subsystem maintenance is performed predominantly at the on-aircraft level.

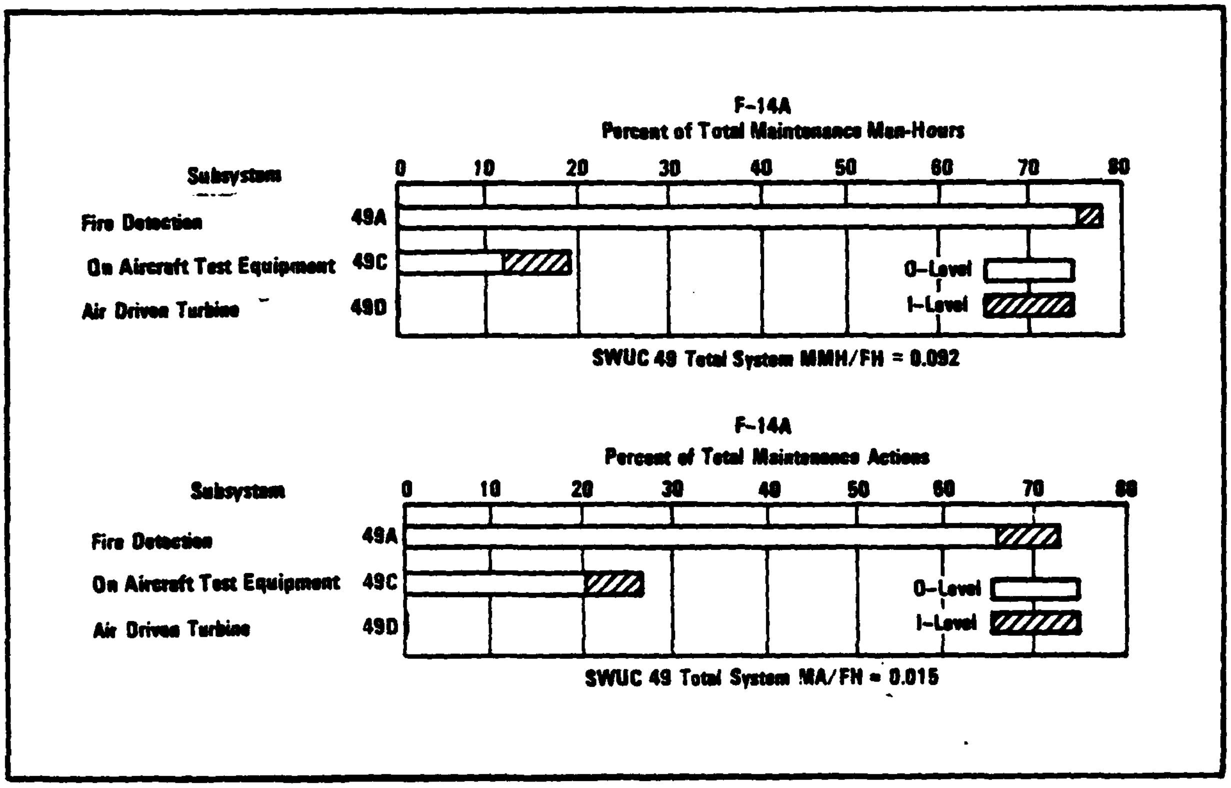


Figure 24. Distribution of F-14A Miscellaneous Utilities System Maintenance (SWUC 49)

The F-14A average repair time is 3.5 hours, slightly exceeding the mean time of 3.0 hours for the eight study aircraft shown in Figure 25. Intermediate level maintenance has a mean repair time of 2.1 hours. This value is somewhat influenced by the relatively large repair time of 12.5 hours reported on the A-4M aircraft. Repair time ranging for the balance of the study aircraft is 0 to 2.1 hours.

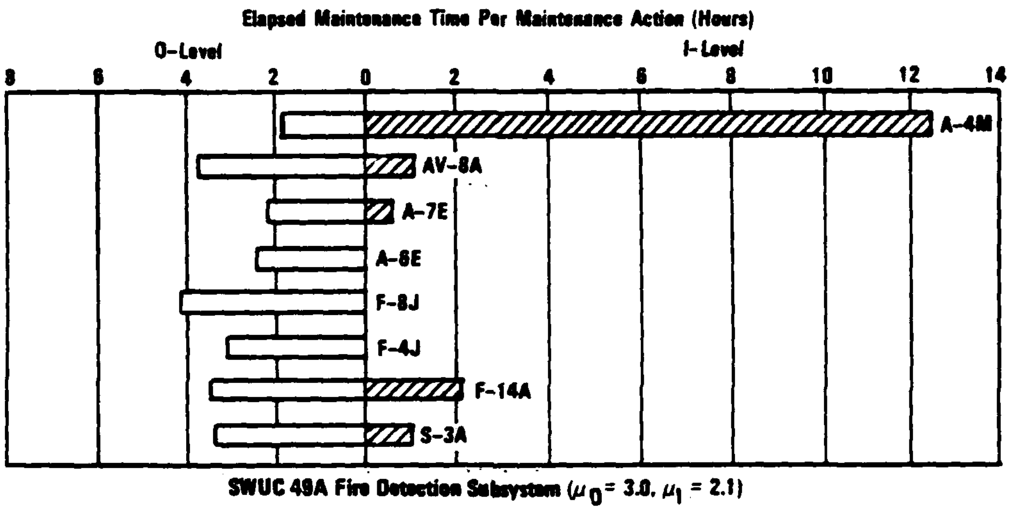
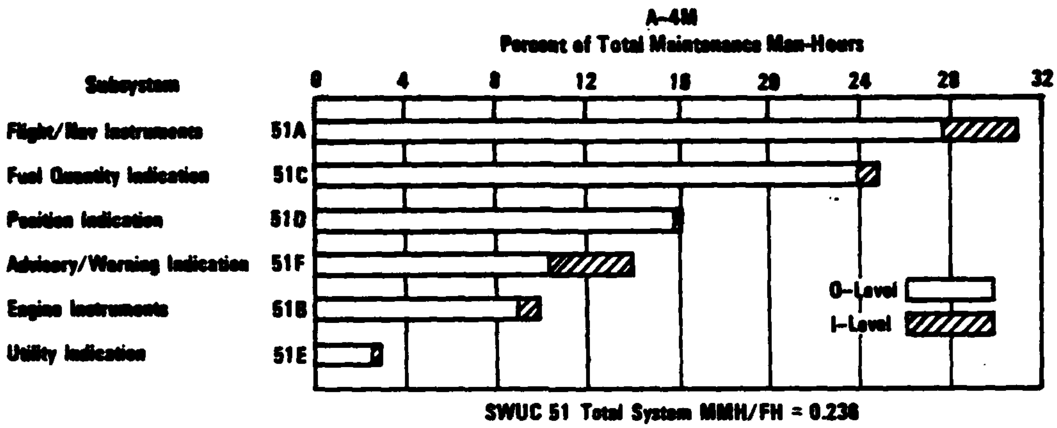


Figure 25. Average Repair Time for Major Miscellaneous Utilities Subsystem (SWUC 49)

3.12 SWUC 51 INSTRUMENT SYSTEM

The Instrument System contributes about 5% of the unscheduled maintenance time expended on the study aircraft. Figure 26 shows a typical distribution of Instrument System maintenance using A-4M data. Within this system three major subsystems, Flight/Navigation Instruments, Fuel Quantity Indication, and Position Indication, account for 72% of the man-hours expended and 77% of the maintenance actions reported.



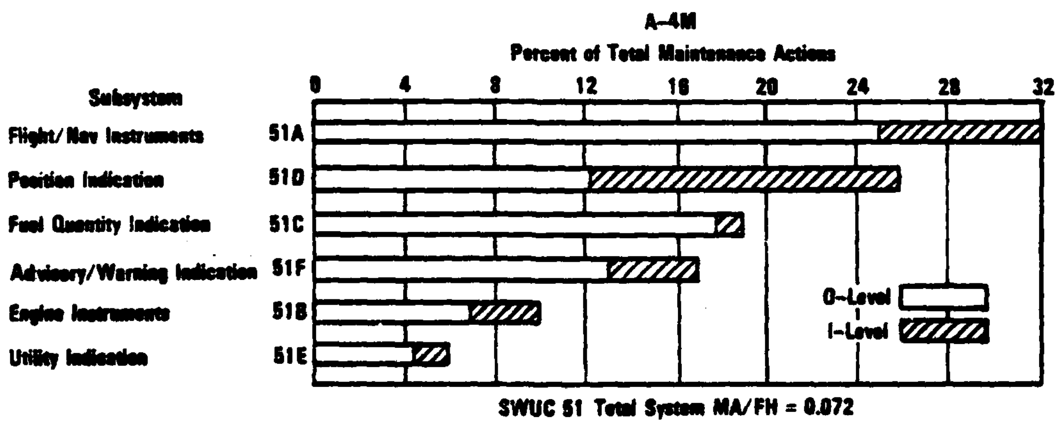


Figure 28. Distribution of A–4M Instrument System Maintenance (SWUC 51)

Figure 27 depicts the average repair times for the three subsystems for each of the eight study aircraft. In each case the majority of the repair time is performed at O-level. For the Flight/Navigation Instruments Subsystem repair time expenditures are stable with individual aircraft averages generally falling within an hour of the mean repair times of 1.8 and 1.4 hours for O and I-level respectively. Wider distributions of repair times are noted for the Fuel Quantity Indication and Position Indication Subsystems at O and I-levels with the widest range of repair times resulting from the Fuel Quantity Indicating Subsystem.

A negative maintainability feature noted in the Instrument System for the F-4J aircraft was the requirement to adjust and calibrate the fuel quantity indicators to the fuel probes prior to securing the indicator in the aircraft. This requirement has a significant impact on the Elapsed Maintenance Time per Maintenance Action (see Figure 27, SWUC 51C, O-level maintenance).

3.13 SWUC 56 FLIGHT REFERENCE SYSTEM

The Flight Reference System accounts for 1 to 5% of the total unscheduled maintenance (MMH/FH) expended on each of the eight study aircraft. Using A-4M data, a typical distribution of Flight Reference System maintenance is shown in Figure 28. The Angle-of-Attack Indication (AOA) and Air Data Computer Subsystems are shown as the major maintenance contributors accounting for 76% of the man-hours and 83% of the maintenance actions expended to support the system.

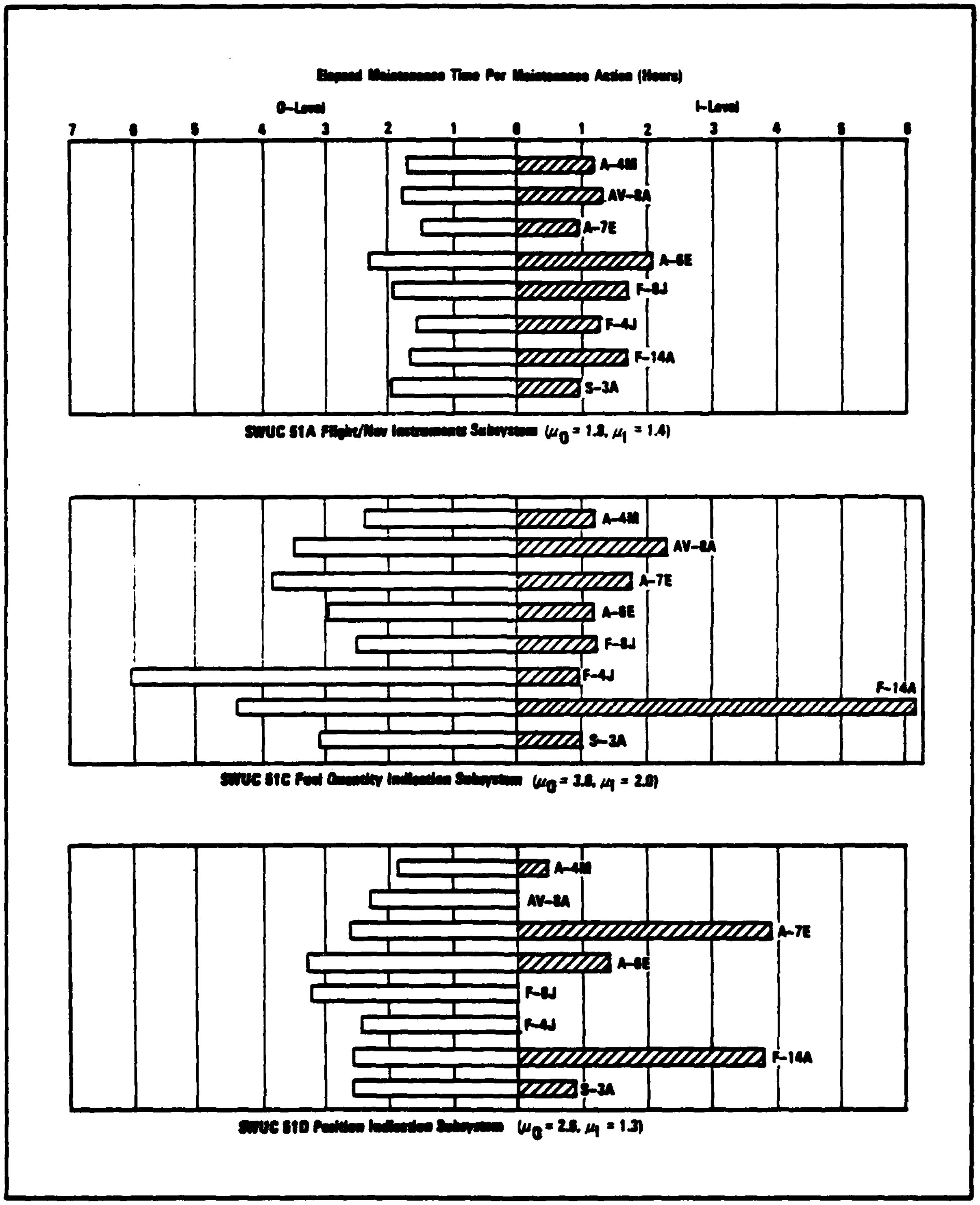


Figure 27. Average Repair Time for Major Instrument Subsystems (SWUC 51)

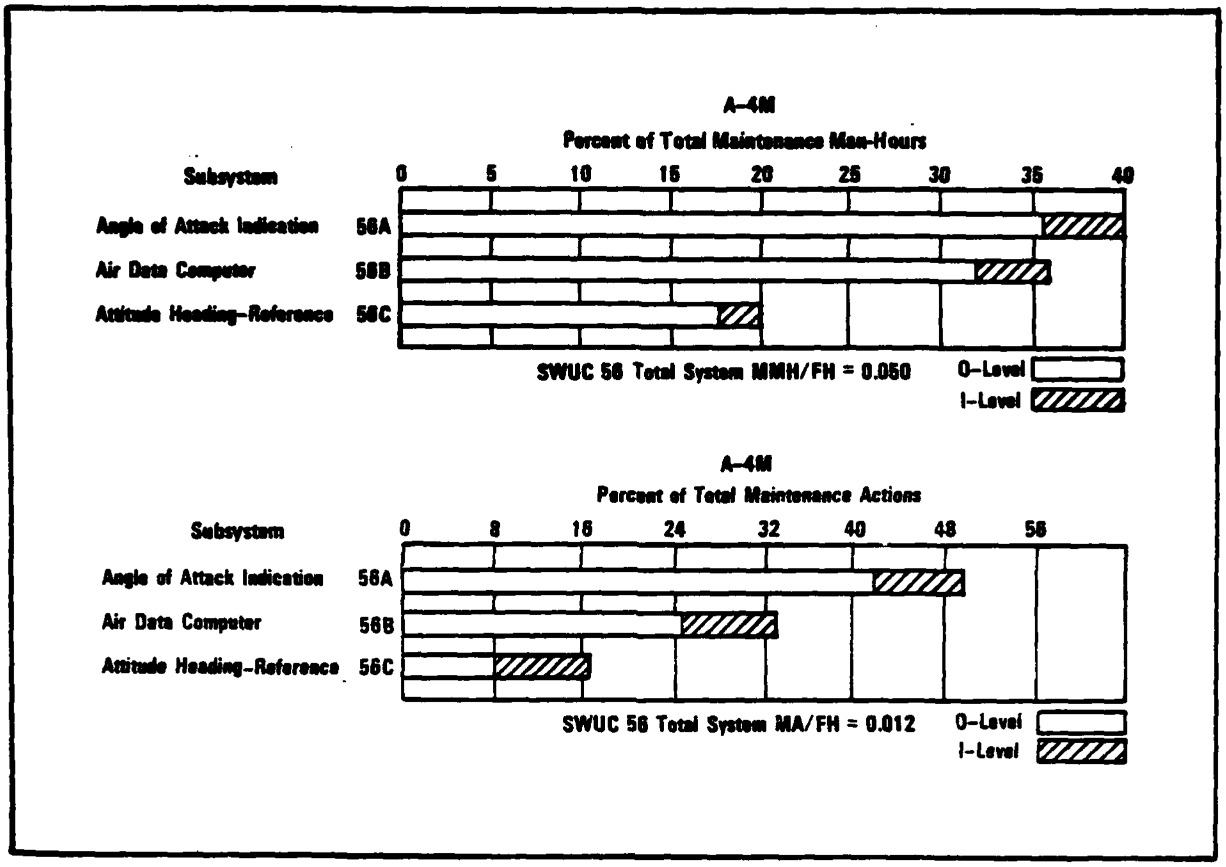


Figure 28. Distribution of A-4M Flight Reference System Maintenance (SWUC 56)

In Figure 29 the average repair times for the contributing subsystems is illustrated for the eight study aircraft. Organizational level maintenance time for the AOA Indication Subsystem is stable about the mean of 1.8 hours. A much wider dispersion of repair times is noted for I-level where the F-14A with a five hour repair time is two and one-half times the mean of the eight aircraft. On-aircraft repair for the Air Data Computer Subsystem is similarly stable about the mean repair time of 1.9 hours for the eight aircraft. The increased complexity of I-level repair is evident in the average times for the AV-8A and F-14A being reported as 10.2 and 11.5 hours respectively against a mean time for all eight aircraft of 6.5 hours.

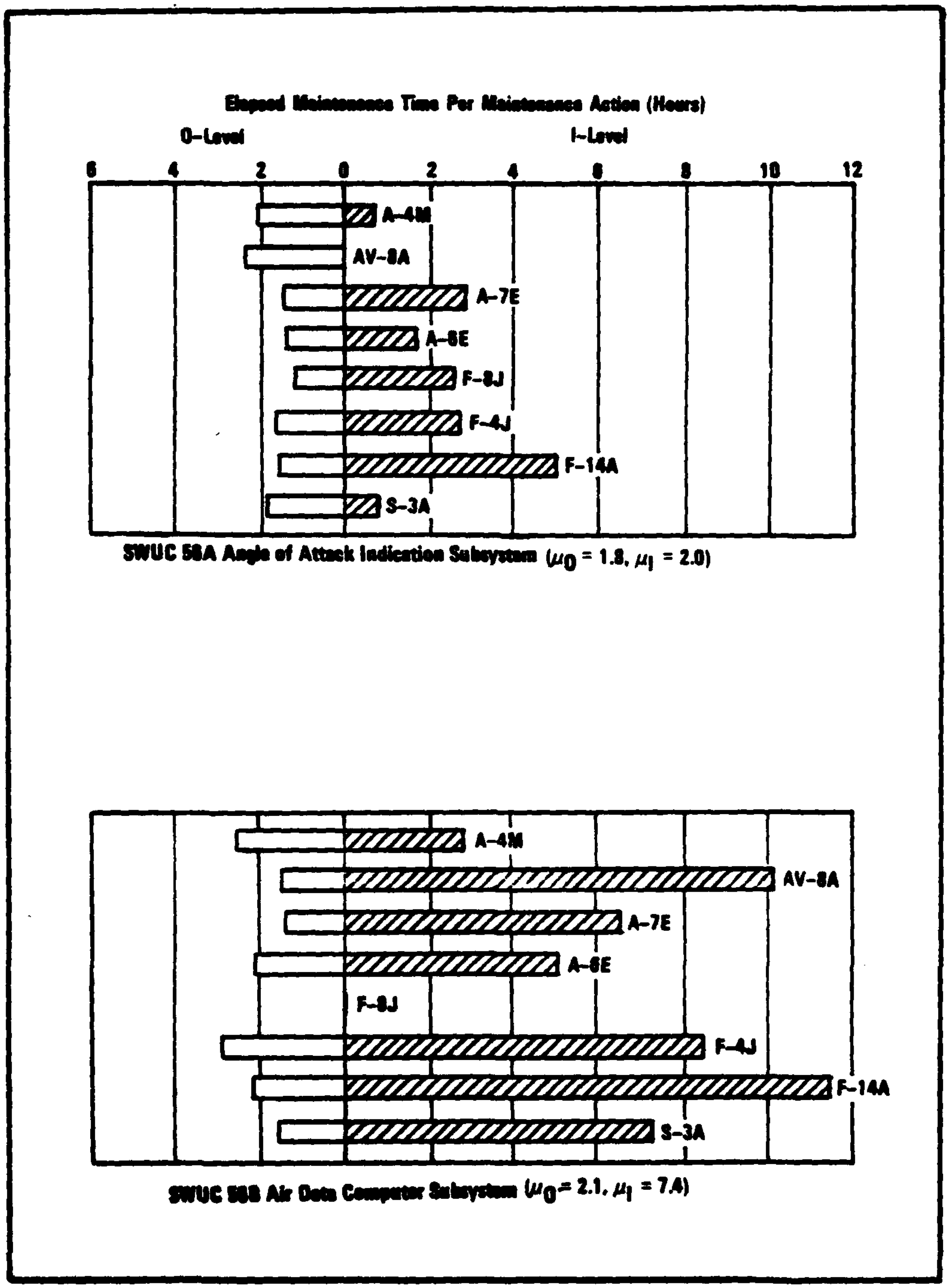


Figure 29. Average Repair Time for Major Flight Reference Subsystems (SWUC 56)

A negative maintainability feature noted in this system was the requirement for removal and replacement of the Angle-of-Attack Transducer in the AV-8A aircraft. To gain access, a panel secured by 14 screws must be removed, wire bundle tie wraps must be cut and subsequently replaced, and even with the panel removed, there is marginal accessibility to the four mounting bolts and electrical connectors. Requirements of this type are what causes increased Elapsed Maintenance Time per Maintenance Action (see Figure 29, SWUC 56A, O-level maintenance). Another negative maintainability feature was noted on the F-4J aircraft where, in order to remove the Air Data Computer, the Ejection Seat and a Receiver-Transmitter (RT) Unit (radio) must be removed (see Figure 29, SWUC 56B, O-level maintenance).

3.14 SWUC 60 COMMUNICATIONS SYSTEM

The Communications System accounts for 4 to 7% of the total unscheduled maintenance (MMH/FH) expended on the eight study aircraft. A typical distribution of communications maintenance based on F-4J data is shown in Figure 30. Of the subsystems listed, the UHF Communications and IFF are the major maintenance consumers accounting for 82% of the man-hours and 75% of the maintenance actions expended. Figure 31 offers a breakdown of the average repair times for each of the eight study aircraft as it pertains to the two major subsystems. On-aircraft repair times (O-level) for both subsystems have some variation but are generally consistent with the mean value of 1.4 and 1.5 hours for the UHF and IFF respectively. The increased complexity of I-level repair is denoted by an increase in the mean repair times to 4.5 and 3.9 hours respectively for these same subsystems. A significantly greater average repair time also is noted for the A-6E and F-4J UHF Communications Subsystem.

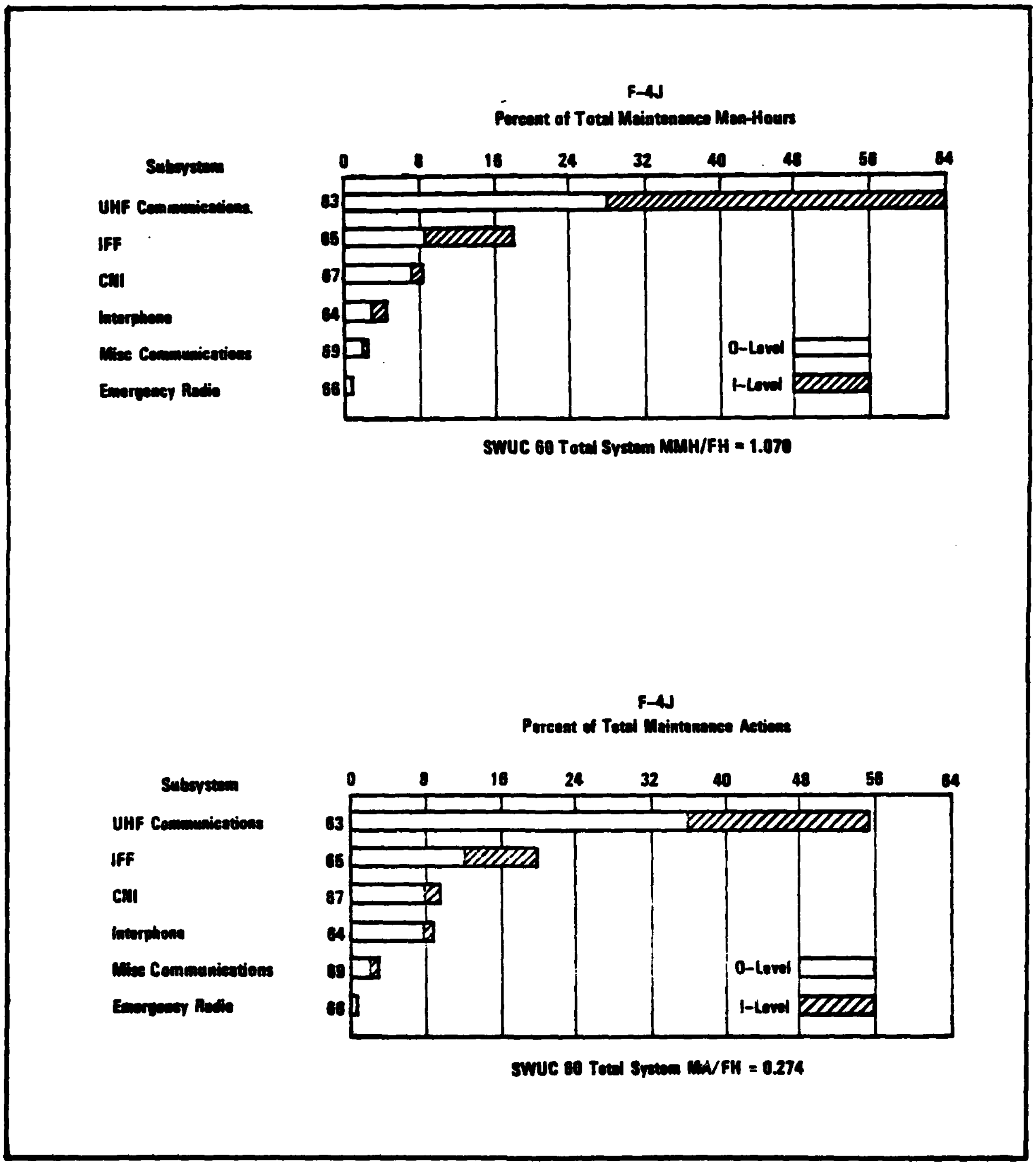


Figure 30. Distribution of F–4J Communications System Maintenance (SWUC 60)

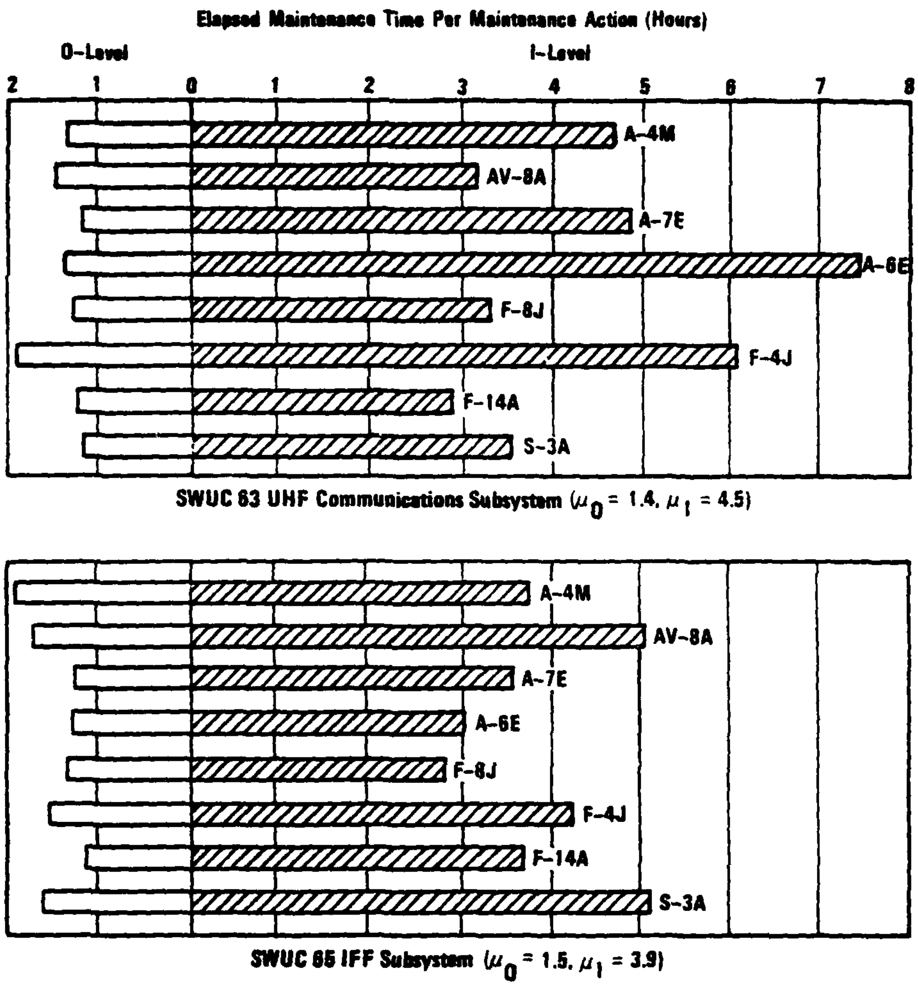


Figure 31. Average Repair Time for Major Communications Subsystems (SWUC 60)

As noted in Figure 31, SWUC 63, O-level, the F-4J indicates a much higher Elapsed Maintenance Time (EMT) per Maintenance Action (MA) than the other aircraft in the study. One reason for the higher EMT/MA is the requirement to remove the Ejection Seat to gain access to the UHF Radio Receiver Transmitter.

3.15 SWUC 71/72/73/74 NAVIGATION/WEAPON CONTROL SYSTEMS

The Navigation/Weapon Control Systems accounted for 16 to 35% of the total unscheduled maintenance (MMH/FH) reported on each study aircraft. Figure 32 shows a typical distribution of subsystem maintenance based on A-7E data. The maintenance requirements are almost equally divided between O and I-level for this control grouping. The top three subsystems, Inertial Nav, Radar Set and Miscellaneous Set/Group, are the major maintenance contributors accounting for 51% of the man-hours and 43% of the maintenance actions expended.

A breakdown of the average repair times for each of the eight study aircraft for the three major maintenance contributors is shown in Figure 33. Because of the large grouping of subsystems in the Navigation/Weapon Control area, only some of the aircraft have repair time expenditures for the major subsystems. The A-7E is the only study aircraft with repair times for all three of the major subsystems. No significant deviations are noted in O and I-level repair times except for the F-8J where the I-level Miscellaneous Set/Group expenditure of about 11 hours is almost twice the A-7E time.

The primary negative maintainability features noted in these subsystems were the lack of Built-In-Test/Built-In-Test-Equipment (BIT/BITE) provisions for repair verification, lack of rack and panel connectors, equipment located at a level which require the use of a maintenance stand for repair, and the lack of quick release fasteners or latches on panels which require removal for access. For example, 41 stress fasteners must be removed from one panel to gain access to the Radar Altimeter RT Unit on the F-4J aircraft.

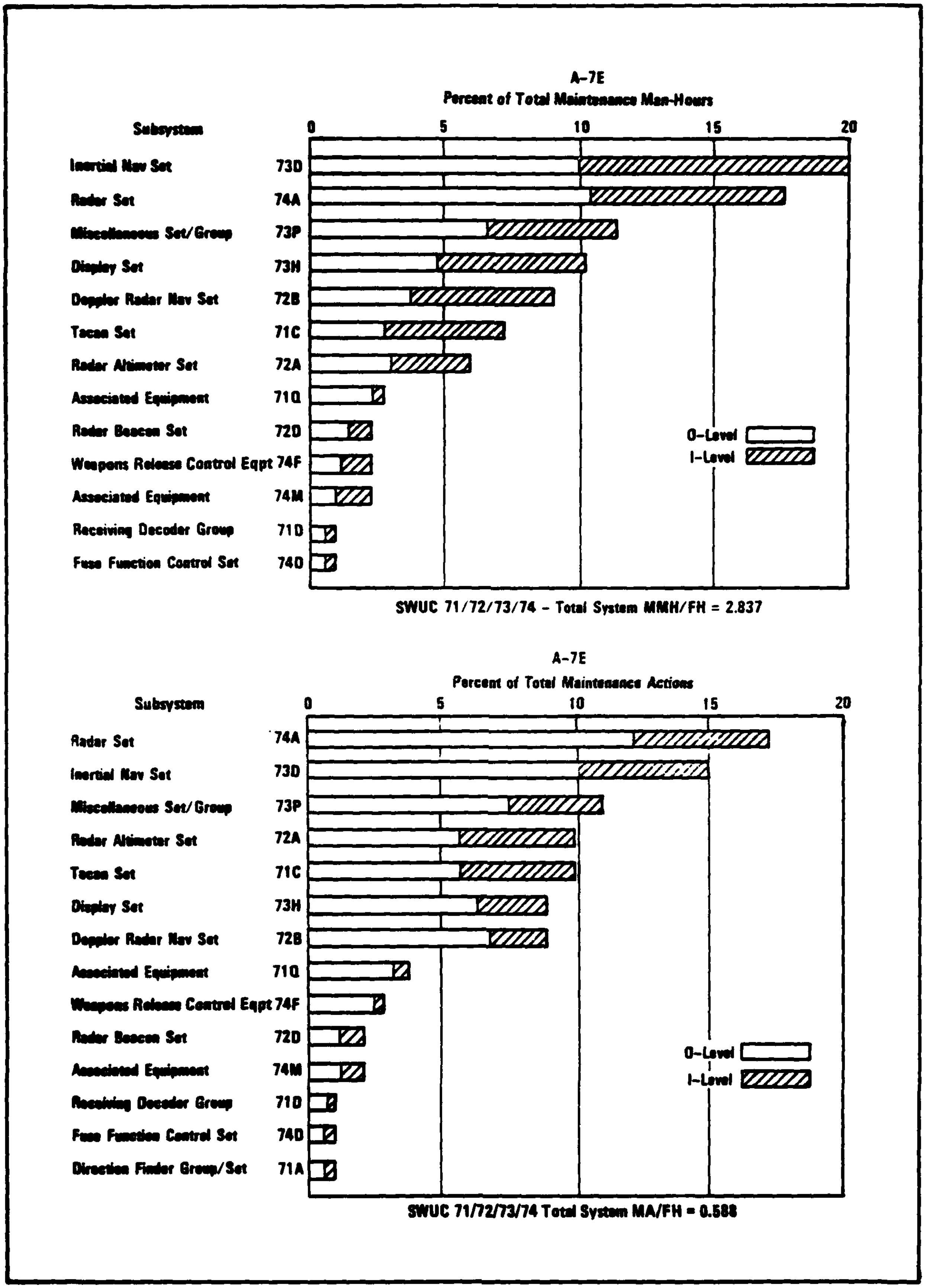


Figure 32. Distribution of A-7E Navigation/Weapon Control System Maintenance (SWUC 71/72/73/74)

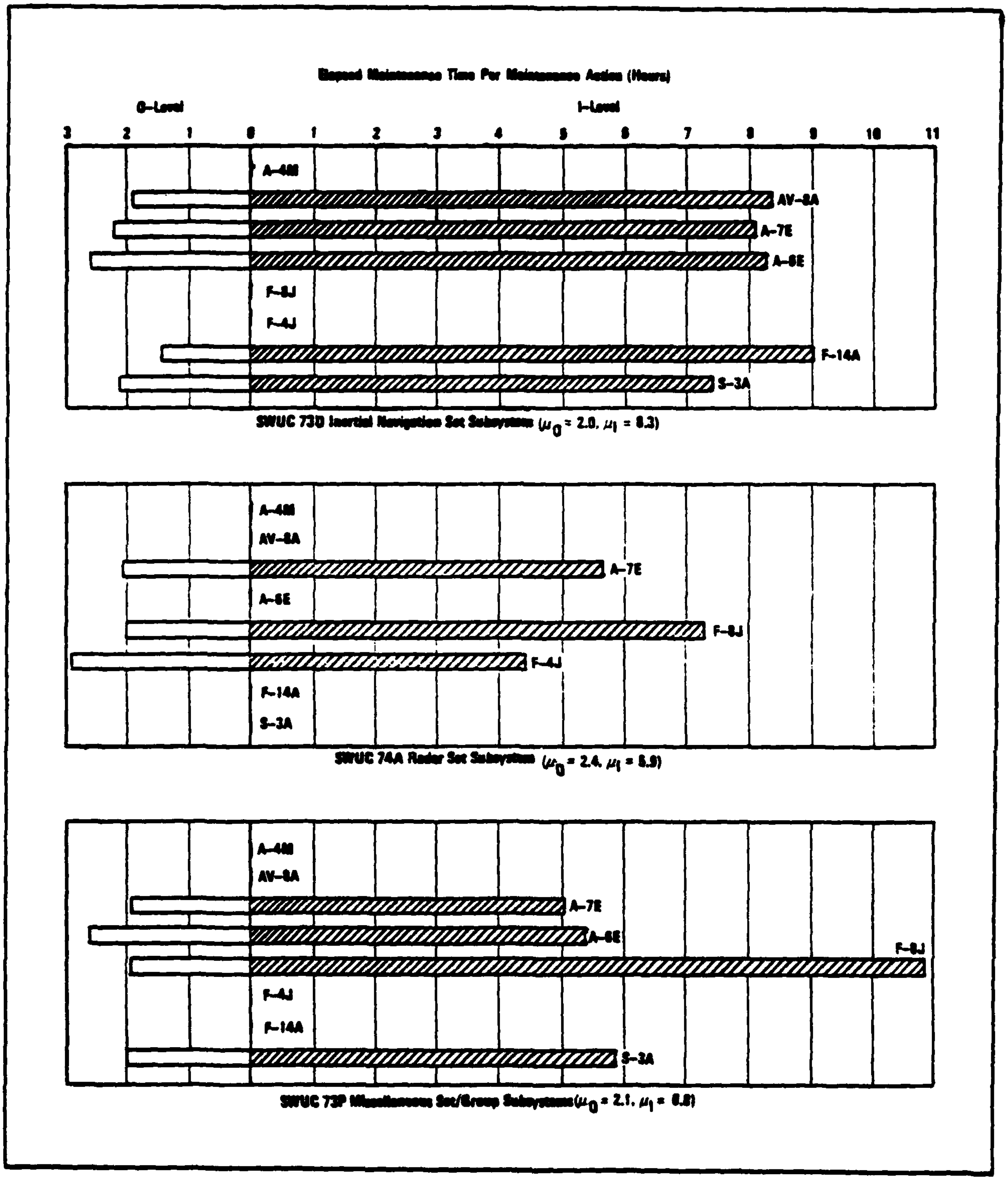


Figure 33. Average Repair Time for Major Navigation/Weapon Control Subsystems (SWUC 71/72/73/74)

3.16 SWUC 75 WEAPONS DELIVERY SYSTEM

The Weapons Delivery System accounts for almost 4% of the total unscheduled maintenance (MMH/FH) reported on the eight study aircraft. A typical distribution of Weapons Delivery System maintenance based on A-7E data is shown in Figure 34. Of the subsystems comprising this system, the Launcher/Racks/Rails is the major maintenance contributor accounting for 63% of the maintenance man-hours expended and 61% of the maintenance actions reported. Man-hour expenditures are almost equally divided between O and I-level maintenance categories.

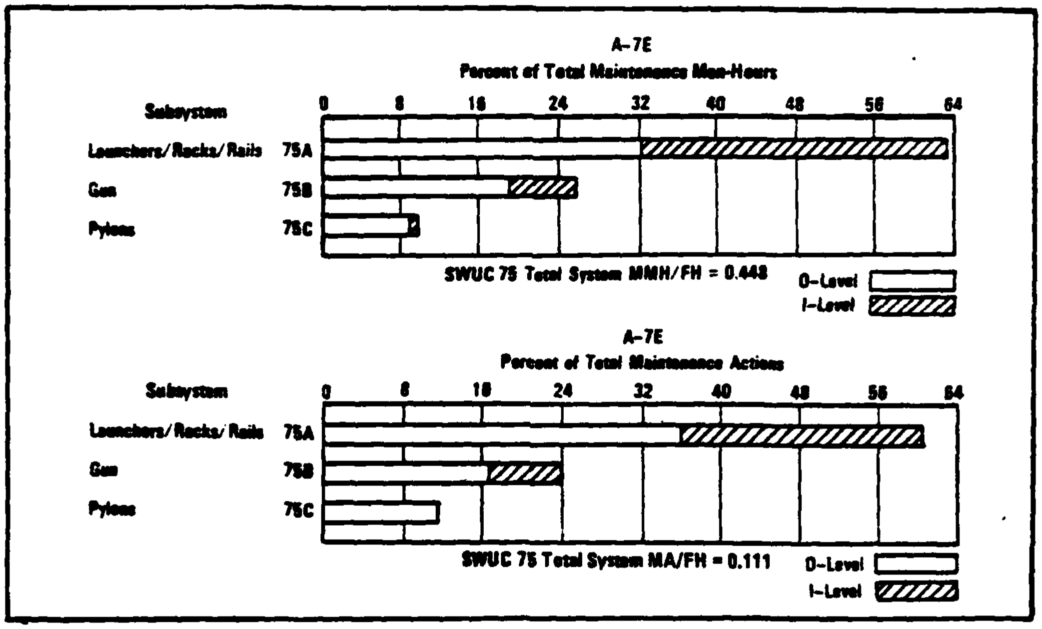
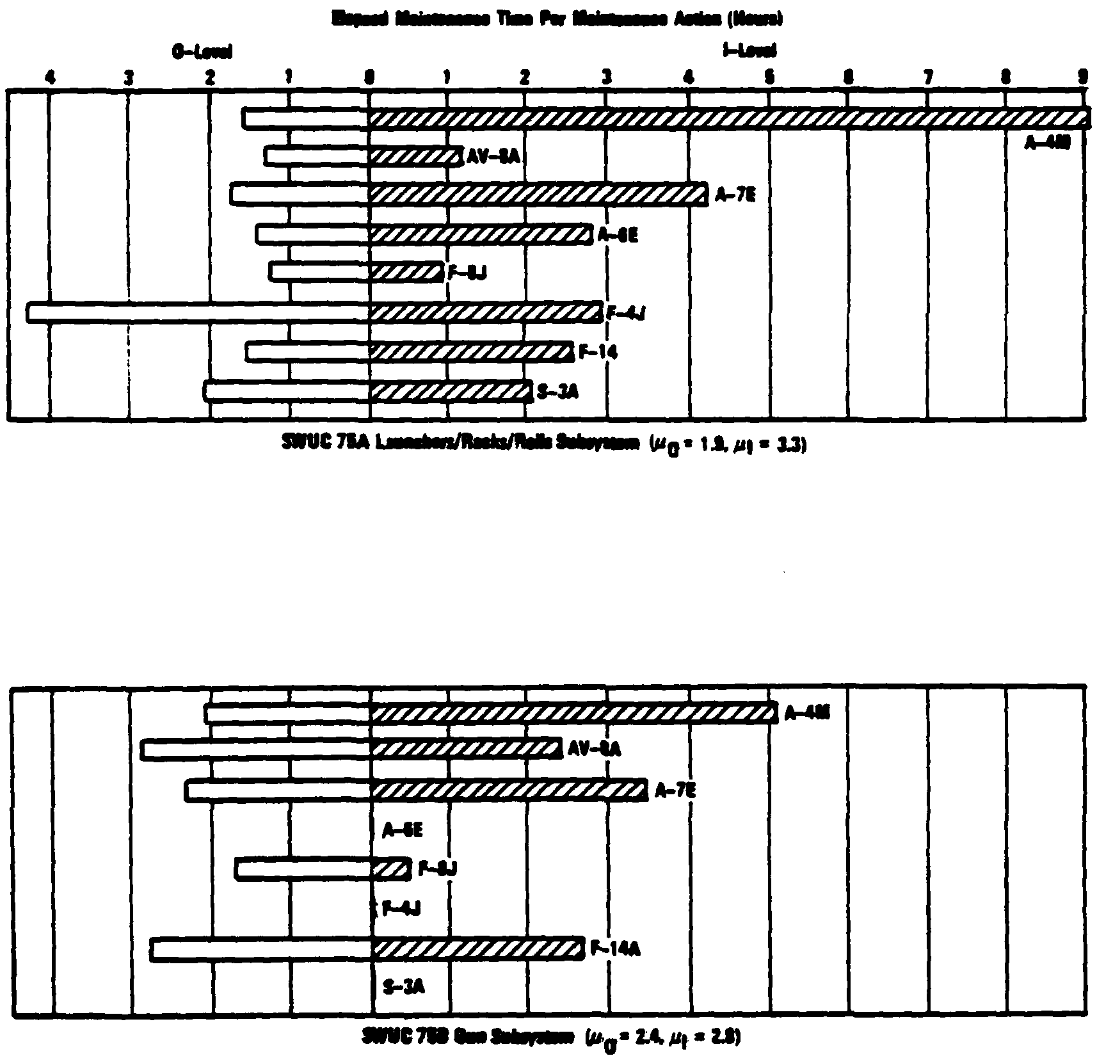


Figure 34. Distribution of A–7E Weapons Delivery System Maintenance (SWUC 75)

In Figure 35 a breakdown of the average repair times associated with each of the eight study aircraft for the major subsystems is presented. The on-aircraft repair times ranged from 1.2 to 2.0 with the F-4J spiking to 4.3 hours, resulting in a mean O-level repair time of 1.9 hours. Intermediate maintenance repair times for this subsystem ranged from less than one hour for the F-8J to a high of over nine hours for the A-4M. The resultant mean repair time was determined to be 3.3 hours.



SWUC 75A Launchers/Racks/Rails Subsystem (μ_O = 1.9, μ_I = 3.3)

SWUC 75B Gun Subsystem (μ_O = 2.4, μ_I = 2.8)

Figure 38. Average Repair Time for Major Weapons Delivery Subsystems (SWUC 75)

3.17 SWUC 76 ECM SYSTEM

The Electronic Countermeasures (ECM) System accounts for about 3% of the total unscheduled maintenance (MMH/FH) reported on the study aircraft with the majority of the maintenance time performed at O-level. Figure 36 shows a typical distribution of ECM maintenance based on F-4J data. The ECM Receiver Set, ECM System/Set/Equipment and Radar Receiver Set are the three subsystems categorized as being prime maintenance contributors accounting for 86% of the maintenance man-hours expended and 86% of the maintenance actions reported.

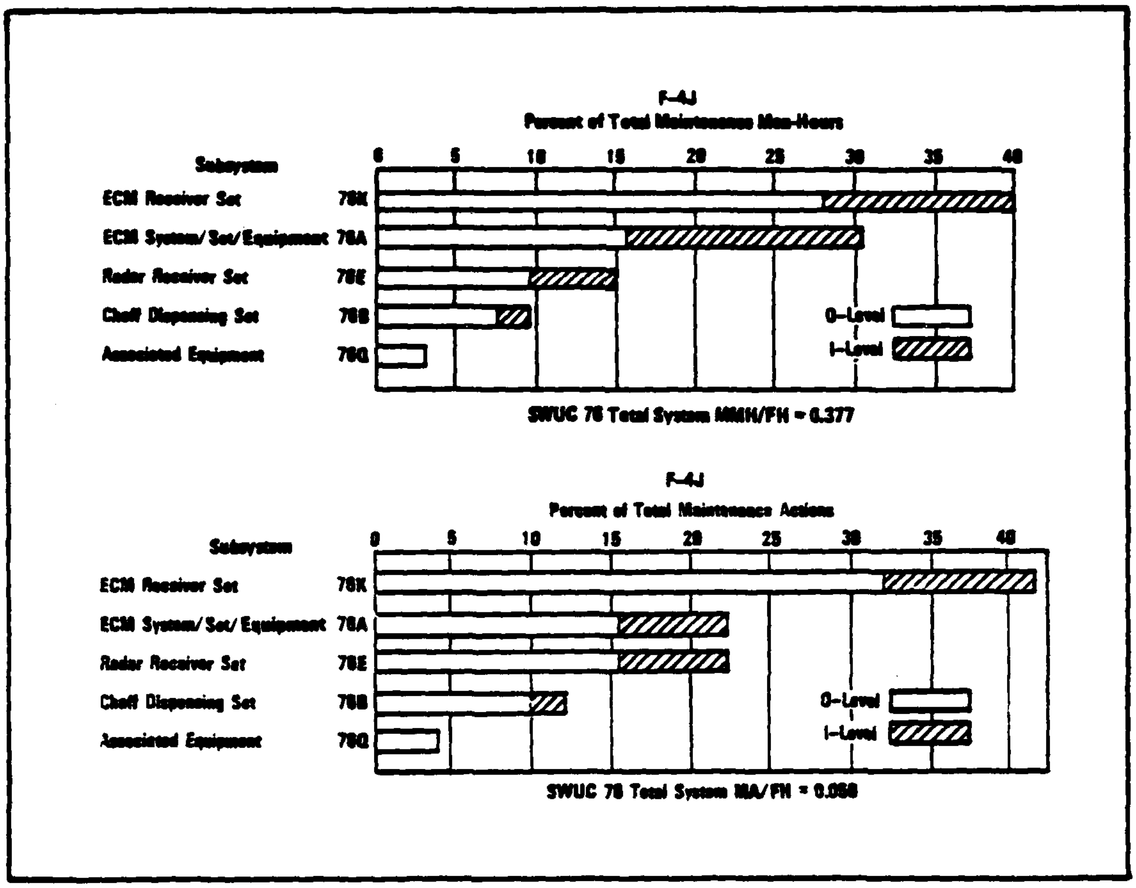


Figure 36. Distribution of F-4J ECM System Maintenance (SWUC 76)

In Figure 37 the average repair times for the three major subsystems are illustrated for each of the study aircraft. Some fluctuation is noted in the on-aircraft repair times but overall the mean times are comparable for each subsystem. Intermediate level repair times show the ECM System/Set/Equipment Subsystem as the prime consumer with a mean repair time of over 14 hours. This is over twice the mean repair time shown by either of the other two subsystems.

A negative maintainability feature noted in this system during the study was on the F-4J aircraft. The ALR-50 Radar Receiver Installation is inaccessible and numerous after installation checks are required on unrelated systems that have to be disturbed to effect removal. The elements that go into making this removal task unacceptable from a maintainability point-of-view are the need to remove 42 fasteners securing the access panel, five units from unrelated systems, a waveguide, and one equipment rack just to gain access to the receiver. The high time recorded to remove and replace the ALQ-100 also is considered a maintainability "driver". The high time primarily is due to the unit's location in the aircraft (upper dorsal area) and the necessity to remove an adjacent unit to accomplish the action. These factors are primary drivers of the Elapsed Maintenance Time per Maintenance Action at O-level maintenance (see Figure 37, SWUC 76K, F-4J aircraft).

3.18 SWUC 90 MISCELLANEOUS EQUIPMENT/SYSTEMS

Miscellaneous Equipment/Systems accounts for less than 1% of the total unscheduled maintenance (MMH/FH) reported on the eight study aircraft. Figure 38 shows a typical distribution of Miscellaneous Equipment/Systems maintenance based on F-4J data. Explosive Devices and Emergency Equipment Subsystems are the major maintenance contributors accounting for 89% of the maintenance

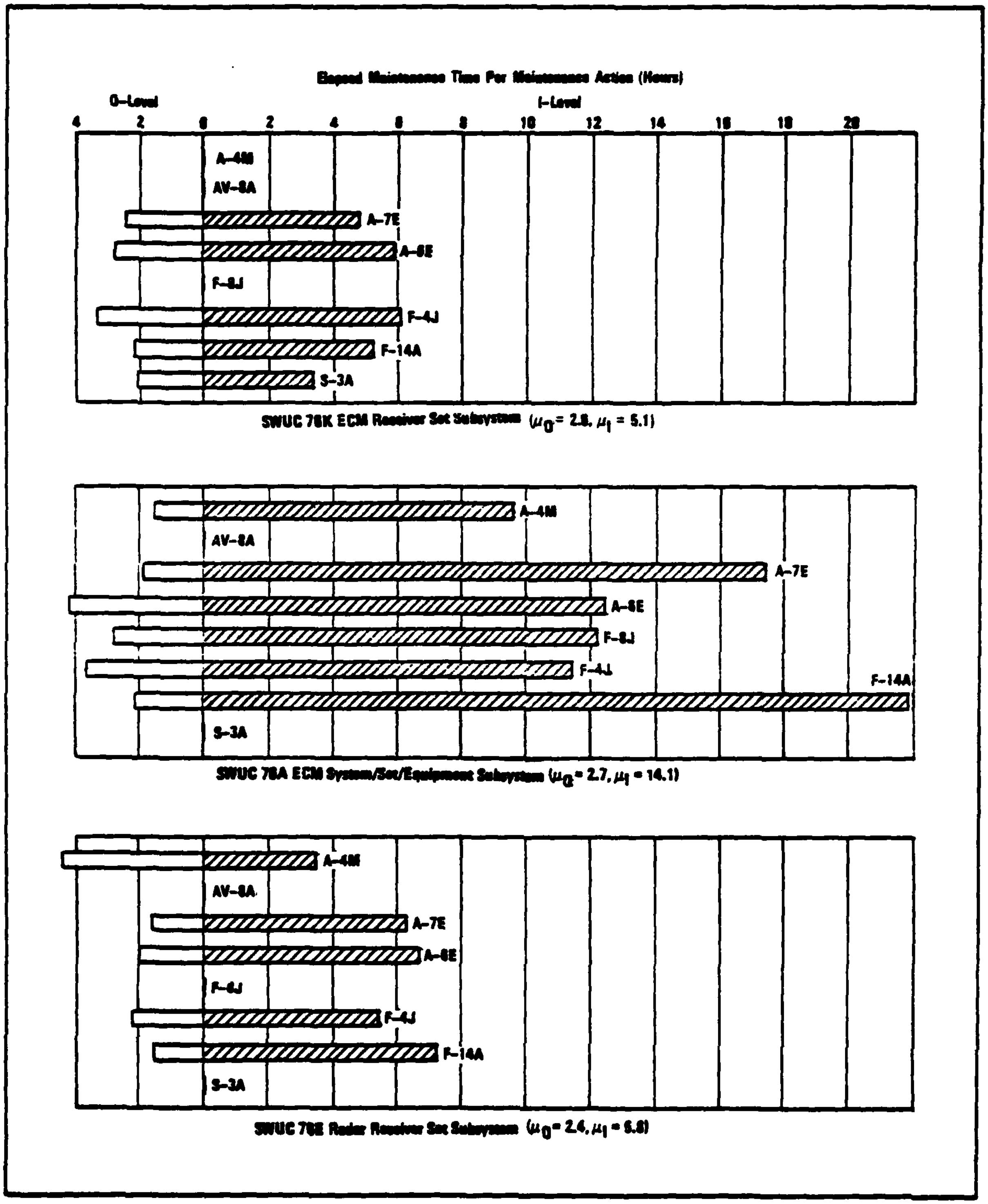


Figure 37. Average Repair Time for Major ECM Subsystems (SWUC 76)

man-hours expended and 77% of the maintenance actions reported. By the very nature of the subsystem, Explosive Devices maintenance is exclusively on-aircraft maintenance. About 25% of the maintenance time expended on the Emergency Equipment Subsystem is I-level.

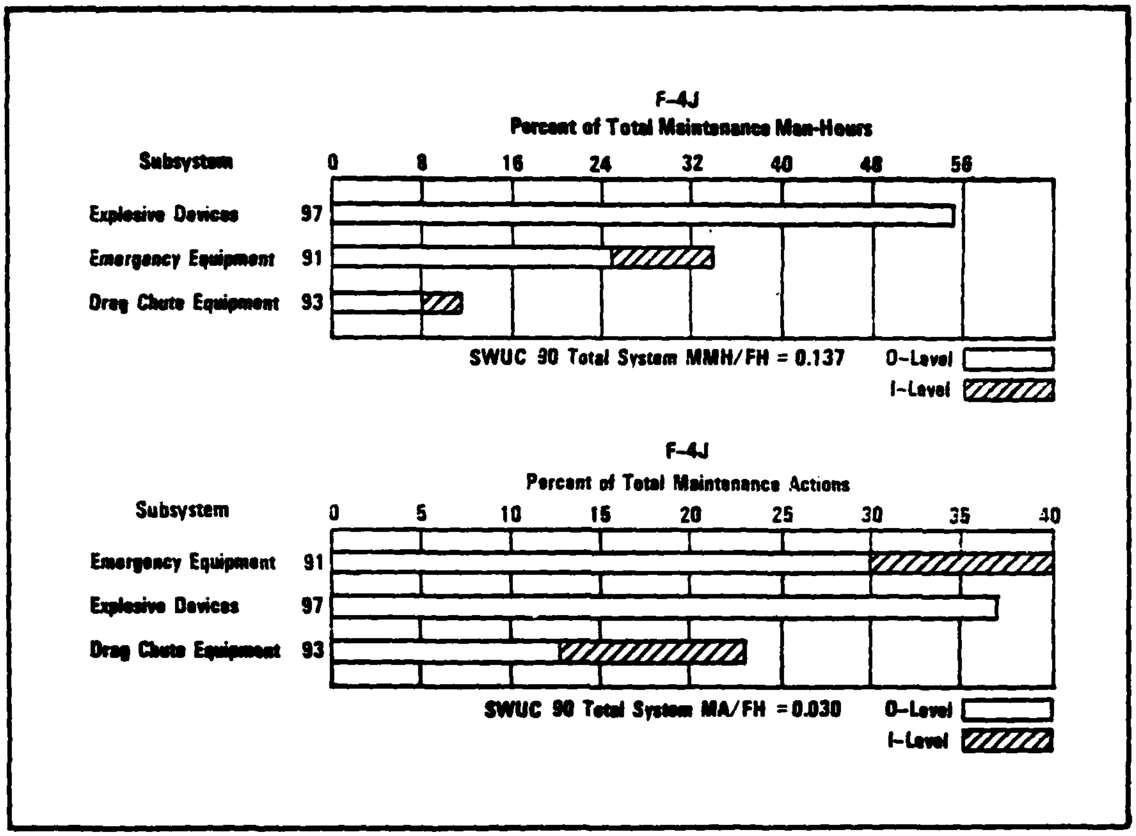


Figure 38. Distribution of F-4J Miscellaneous Equipment/Systems Maintenance (SWUC 90)

Figure 39 presents a breakdown of average repair times for the two subsystems as they pertain to each study aircraft. Under the Explosive Devices Subsystem, the F-14A had the lowest average repair time (1.4 hours) while the A-6E recorded the high average time, 8.4 hours. Five of the eight aircraft fell below the mean repair time of 3.8 hours. The F-4J, as a typical aircraft, had an average repair time of 3.4 hours for both O and I-level maintenance under the Emergency Equipment Subsystem. Other I-level excursions ranged from 1.5 to 9.5 hours.

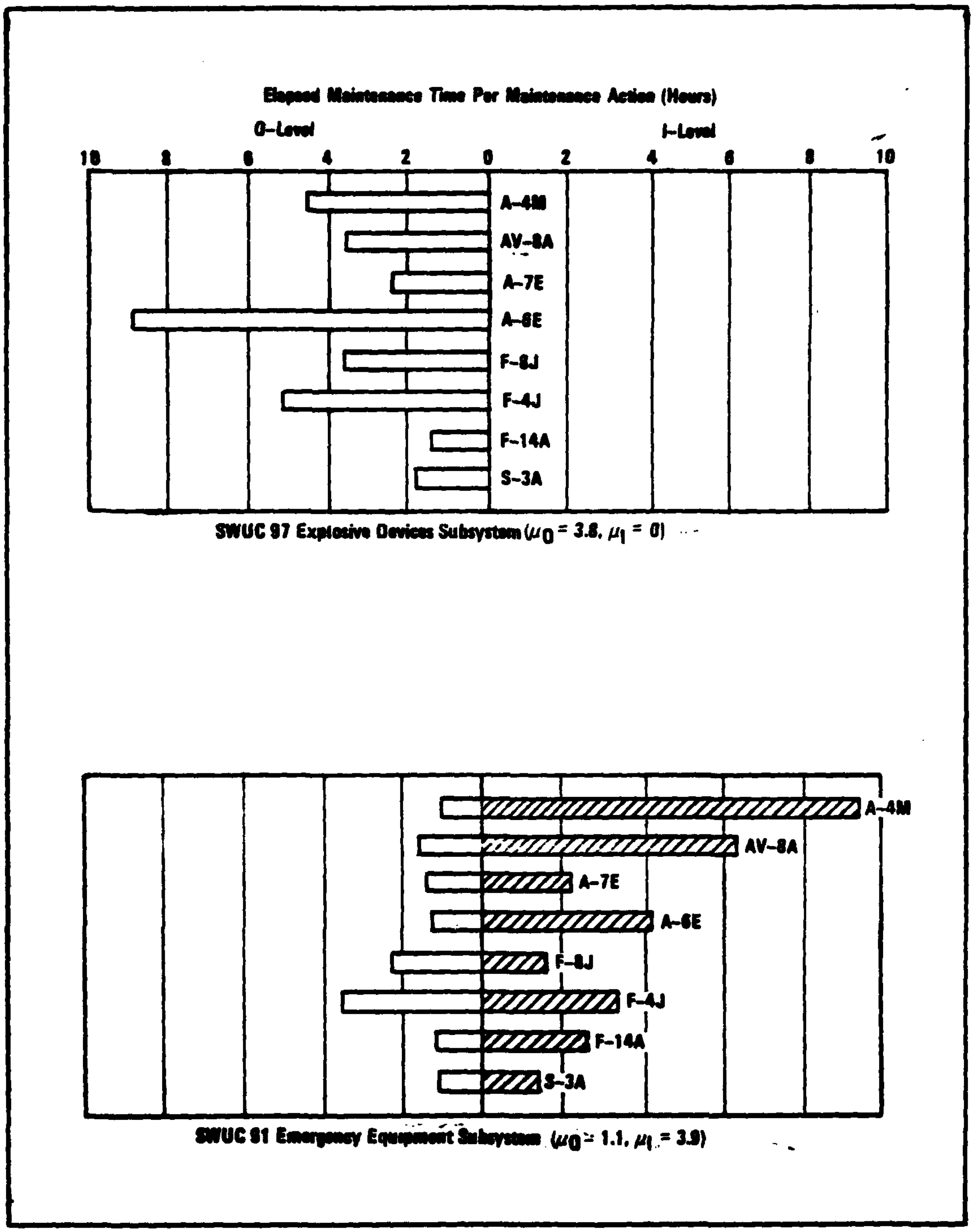


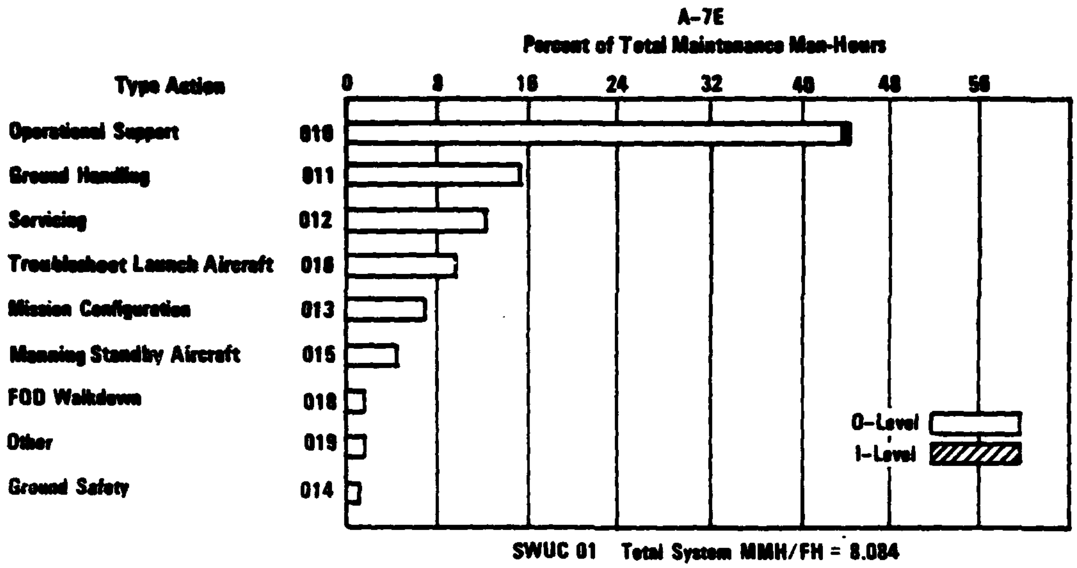
Figure 39. Average Repair Time for Major Miscellaneous Equipment Subsystems (SWUC 90)

3.19 SWUC 01 OPERATIONAL SUPPORT SYSTEM

The Operational Support System accounts for the largest portion of the reported expenditures of aircraft maintenance, averaging approximately 27% of the total aircraft maintenance time and 48% of the total maintenance time reported under all Support Action Codes for the eight study aircraft. Figure 40 shows a typical distribution of man-hours and actions for the Operational Support System based on A-7E data. Of the subsystems listed, the Operational Support Subsystem is the major maintenance consumer accounting for 45% of the man-hours expended and 39% of the maintenance actions reported. Only, Servicing and Troubleshooting Launch Aircraft Subsystems, which account for 23% of the man-hours and 27% of the maintenance actions, are considered design related and germane in predicting technology improvement of a new design.

3.20 SWUC 03 SCHEDULED AIRCRAFT INSPECTIONS

One of the larger maintenance expenditures is recorded against Scheduled Aircraft Inspections. Approximately 19% of the total aircraft maintenance time and 33% of the total support action time was the average expenditure reported on the eight study aircraft for scheduled maintenance. Figure 41 illustrates a typical distribution of the maintenance expenditures for Scheduled Aircraft Inspections based on F-14A data. Daily/Special and Turnaround/Preflight Inspections are considered the prime contributors to the cost of maintenance accounting for 64% of the man-hours expended and 88% of the maintenance actions reported. Both of the inspection categories are considered as being design related support action tasks and should be considered in the technology improvement prediction during evaluation of new designs.



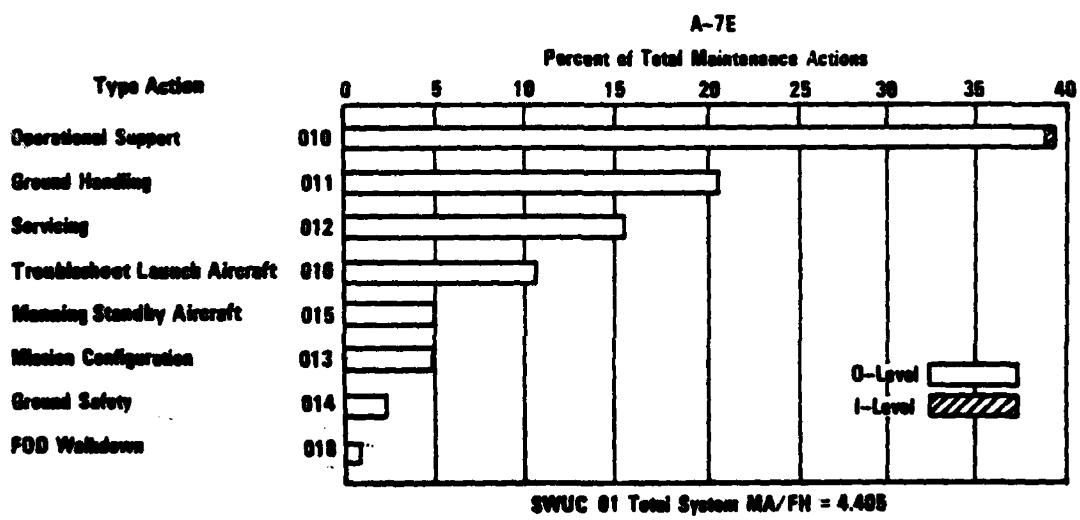


Figure 40. Distribution of A-7E Operational Support Maintenance (SWUC 01)

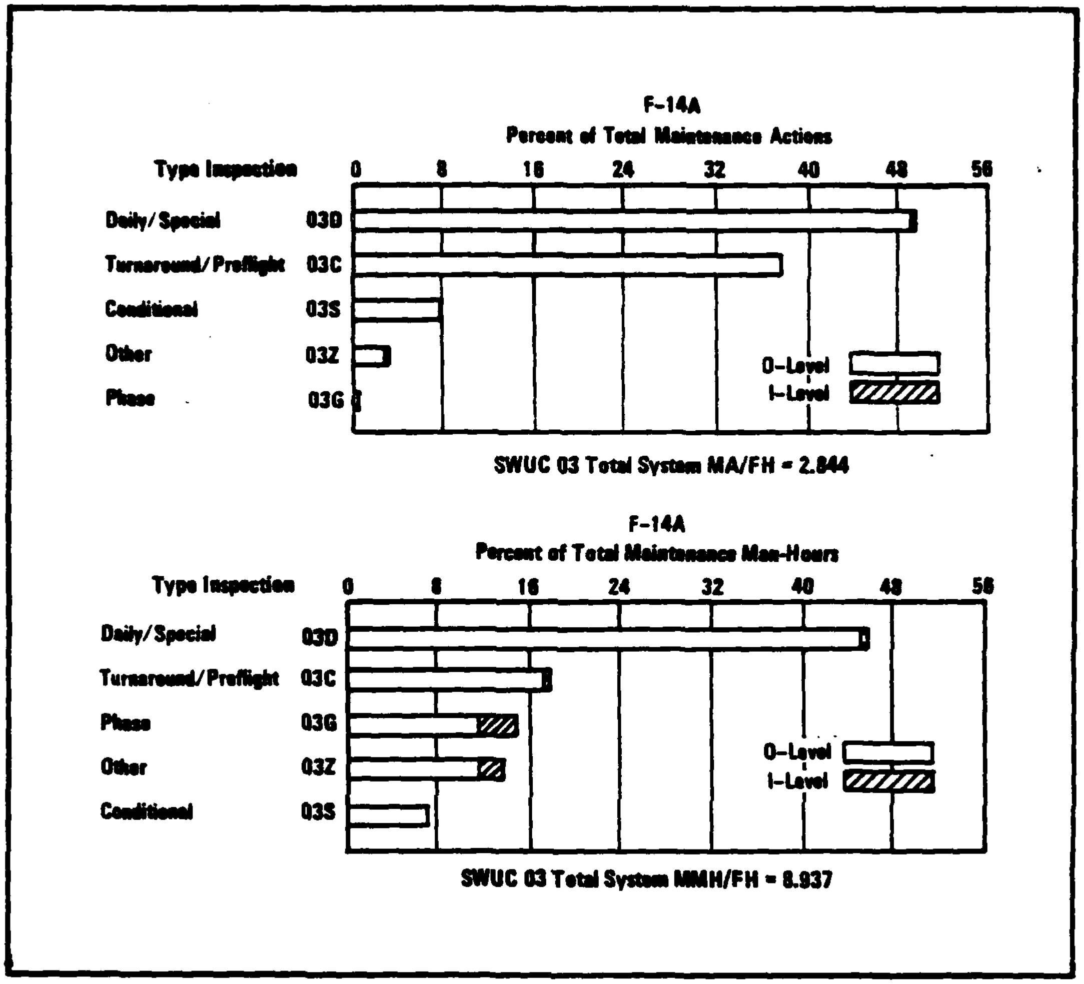


Figure 41. Distribution of F-14A Maintenance Expended for Scheduled Aircraft Inspections (SWUC 03)

3.21 SWUC 05 SHOP SUPPORT MAINTENANCE

The Shop Support maintenance tasks account for approximately 10% of the total support action effort and 6% of the total MMH/FH expended on the eight study aircraft. A presentation of the Shop Support Maintenance distribution is shown in Figure 42 based on A-6E data. The General Functions and Mission Shop Support are the two support action consumers accounting for 71% of the man-hours expended and 90% of the maintenance actions reported. The Mission Shop

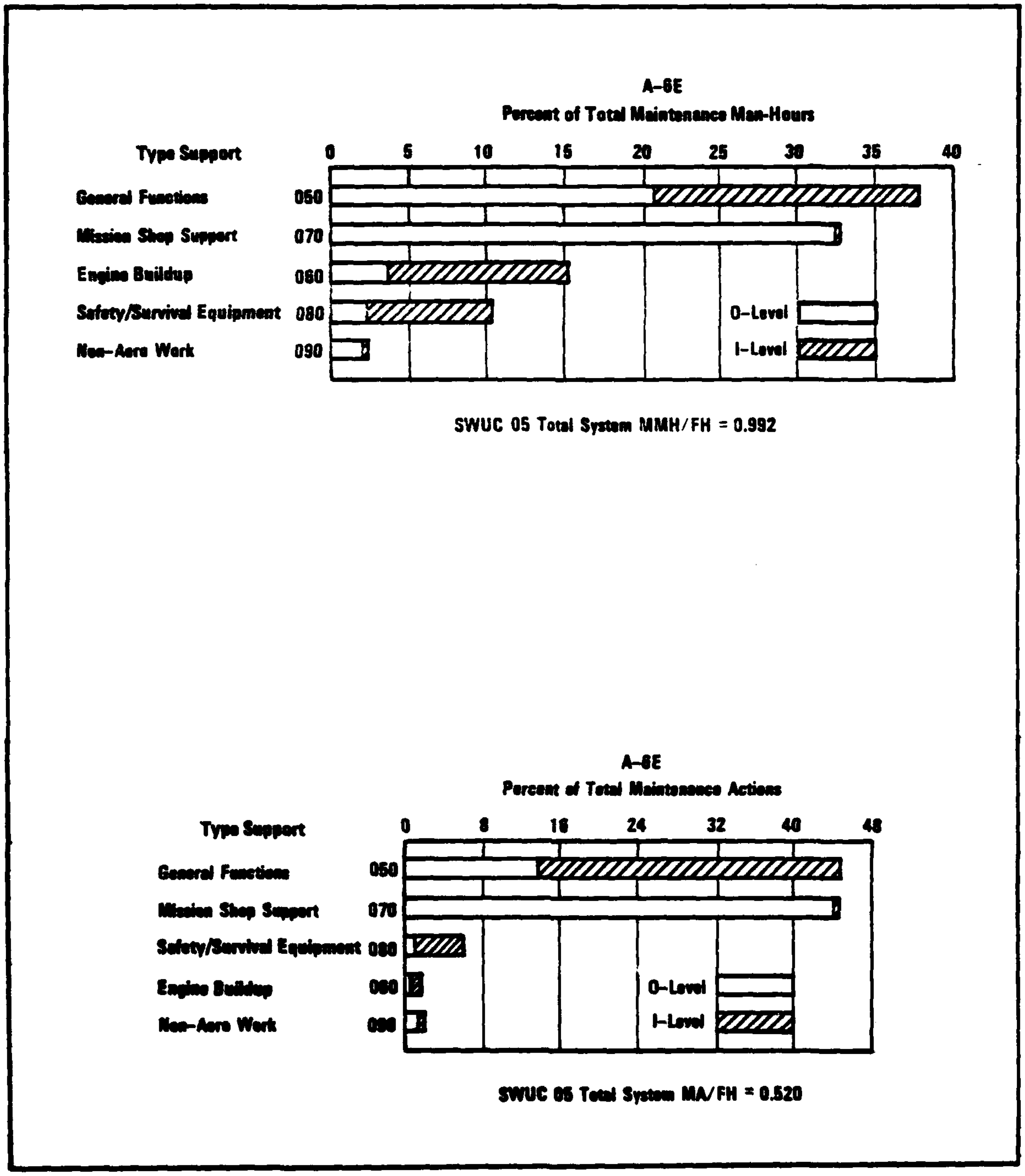


Figure 42. Distribution of A-6E Shop Support Maintenance (SWUC 05)

Support Subsystems are not generally considered design related, making it difficult to establish a technology improvement during the evaluation of a new design.

3.22 SWUC 24/47/57/77/02/04 SINGLE ELEMENT STRUCTURE SYSTEMS

Six of the SWUC's were not included in the graphic representation of this section because of the single element structure of these systems. The six codes included are: SWUC 24 - Auxillary Power Plant, SWUC 47 - Oxygen, SWUC 57 - Integrated Guidance/Flight Control, SWUC 02 - Cleaning, and SWUC 04 - Corrosion Prevention.

In each case the majority of the maintenance effort was performed at O-level. The first four Work Unit Codes were reviewed for their impact on the total unscheduled MMH/FH expended on each aircraft. The only significant contribution was noted in the Integrated Guidance/Flight Control System (SWUC 57) where system support costs accounted for 6.9% of the total maintenance time expended by the F-8J. Other aircraft ranged from 1.8 to 3.2% for this system. The remaining two codes (SWUC 02 and 04) were related to the total support action expenditures. Only the Corrosion Prevention (SWUC 04) category was significant with maintenance expenditures ranging from 9.0 to 12.8% for the study aircraft with the A-7E and F-14A being the largest contributors at 12.0 and 12.8% respectively.

4.0 TECHNOLOGY IMPROVEMENT EVALUATION

4.1 TECHNOLOGY IMPROVEMENT FACTOR (TIF)

The Maintainability Index Model (MIM) calculates baseline maintenance requirements reflecting state-of-the-art technology and its corresponding R&M effort. Engineering improvements which reduce maintenance resources and frequency of maintenance in a new design are measured by comparison of the contractor predicted maintainability factors to the MIM baseline. A positive (or negative) delta from the MIM baseline is referred to as a Technology Improvement Factor (TIF). The MIM provides a method of calculating a TIF for each individual system.

4.2 TECHNOLOGICAL FORECASTING

Technological forecasting during the conceptual design phase is a difficult task. This results from the fact that both the predicted technology improvements and an evaluation of the predicted improvements are subjective in nature. A great amount of difference can result between a highly optimistic prediction and a highly pessimistic evaluation of the prediction.

A good evaluation of predicted technology improvements in a system is one that can verify, with a reasonable degree of certainty, that improvement or lack of improvement will result from innovations of the design. In most instances, it will not be possible to quantify the exact amount of improvement prior to an operational evaluation of the system.

The Maintainability Index Model (MIM) presented in the "Aircraft Maintenance Experience Design Handbook" (reference 1) provides the point of departure and the need for an evaluation of predicted improvements in a system. The MIM was developed using actual operational maintenance data and design performance parameters of several systems. These systems, in one form or another, employ most or all of the known technology available today. It is logical then, to assume, that significant maintainability improvements are not possible without a major breakthrough in technology. However, there are some areas within today's technology where innovations in design can influence resources and requirements which will result in some overall technological or maintainability improvement for a system. Many of the areas where improvements are possible are documented in section three of this study.

4.3 CRITERIA FOR EVALUATING TECHNOLOGY IMPROVEMENT FACTORS

The criteria selected for system technology evaluation is the Technology Improvement Factor (TIF). A number of techniques can be used for quantifying subjective judgements with the most common being some form of scaling. In subjective scaling, a number replaces semantics as a way of communicating one's judgement of a qualitative concept. In the MIM, TIF's are used to measure MMH/FH and MA/FH improvements or degradations over a baseline system. The following procedure may be used to evaluate TIF's.

Figure 43 shows technology improvement sensitivity as a function of MMH/FH = 1.0. The graph shows that the predicted MMH/FH value for the given system is a 40% improvement over an equivalent baseline design.

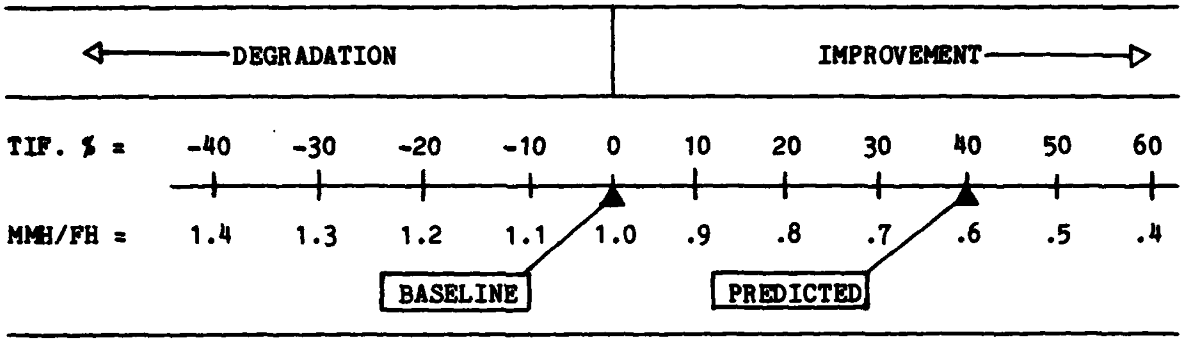


Figure 43. Example Technology Improvement Factor Rating Scale

An evaluator must be able to relate this value to the design predicted by the contractor. Use of the following steps is recommended in an effort to formalize the decision making process:

(1) Determine what new technology is being used in the system. New technology is defined as equipment/components, installations, structure, etc., not previously used in the baseline system. Ensure that the new technology is not more complex and does not require more maintenance than the system it replaces. Consult the contractor's proposal for substantiating rationale on system reliability and maintainability (R&M) design features. If no new technology is being implemented in a system, then the evaluation must become increasing pessimistic since the baseline represents the results of essentially the same technology.

(2) Relate the impact of the contractor's design to the maintenance significant areas identified in Section 3.0 of this study. Significant technology improvements cannot be realized unless the drivers of system maintenance are impacted.

(3) Consult the checklist in Table 2 for TIF variability. Identify those factors which have the greatest impact on the contractor's predictions. For example, a negative technology improvement factor may not always be the result of a more complex system. Sometimes data base incompatibility may yield false values. That is, the contractor's data base may be from a different time period than the model in which case the evaluator must make allowances to account for this variation.

As previously discussed, a completed evaluation may not result in exact quantitative results. However, the completed evaluation should provide a good indication of the validity of the contractor's predicted technology improvements. The actual improvement may not be verified until hardware testing or until the system becomes operational.

TABLE 2. TIF EVALUATION CHECKLIST

A. DEGRADATION

1. More complex system - increase in functional capability of equipment.
2. Increase in the number of WRA's - system requirement for additional equipment.
3. Data base incompatibility - contractor's historical maintenance data base differs significantly from model data base.
4. Analyst pessimism.
5. Maintenance concept mismatch - skill level, training required, level of repair.

B. NO CHANGE

1. Equipment commonality - same equipment used in both aircraft.
2. System R&M design features have negligible impact on units of measurement.
3. No significant change in system technology.

C. IMPROVEMENT

1. Design simplicity.
2. Quick and easy access to all equipment.
3. Application of Automatic Test Equipment (ATE) and BIT to improve fault isolation.
4. Correction of defects on past systems - see Section 3.0.
5. Use of new equipment designed for R&M.
6. Use of latest state-of-the-art, proven, reliable, off-the-shelf equipment.
7. Maintenance tasks simplification.
8. Re-allocation of some troubleshooting/repair tasks to I-level.
9. Changes in scheduled maintenance concept which takes advantage of Reliability Centered Maintenance.
10. Analyst optimism.
11. Data base incompatibility - contractor's data base differs from model data base.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The validation of a contractor's maintainability predictions during the conceptual design phase of a system must be accomplished primarily by a subjective evaluation of the design innovations.

A customer for a new system must be cautious of significant predicted maintainability improvements compared to a baseline of operational performance and design characteristics unless there has been a major breakthrough in maintainability technology.

System complexity, equipment commonality and design philosophy all tend to reduce any significant reductions in maintainability resources and requirements.

5.2 RECOMMENDATIONS

To provide a data base from which a customer can complete an objective evaluation of a contractor's maintainability prediction during the conceptual design phase, the Request-for-Proposal (RFP) must require the contractors to provide a more complete definition of the maintainability qualitative design features of the new system.

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APPENDIX A

AIRCRAFT SUBSYSTEM MMH/FH DATA

Table A-1.1 Navy Fighter/Attack/ASW Aircraft Standard Work Unit Code Report
Matrix of Navy Aircraft Class 1 MMH/FH O+I Level Data By 3 Digit SWUC

SYSTEM/SUB-SYSTEM	STD WUC	A-4M	AV8A	A-7E	A-6E	F-8J	F-4J	F14A	S-3A
AIRFRAME	11	.370	.633	1.141	.951	1.516	1.632	1.934	.794
STRUCTURE	11A	.250	.359	.675	.600	1.101	.935	.907	.395
ACCESS DOORS/PANELS	11B	.020	.111	.231	.169	.307	.422	.594	.189
WINDSHIELD	11C	.007	.011	.027	.015	.030	.030	.029	.142
CANOPY	11D	.070	.096	.096	.119	.013	.100	.230	-
WINGFOLD	11E	-	-	.029	.044	.065	.043	-	.140
FUSELAGE	12	.052	.113	.082	.103	.067	.487	.189	.090
EJECTION SEAT INSTALLATION	12A	.036	.101	.048	.083	.061	.444	.110	.050
COCKPIT EQUIPMENT	12B	.016	.012	.027	.020	.085	.040	.060	.036
LANDING GEAR	13	.053	1.067	.089	.962	1.173	1.444	1.040	1.109
MAIN LANDING GEAR AND DOORS	13A	.095	.104	.111	.311	.169	.322	.448	.095
NOSE LANDING GEAR AND DOORS	13B	.022	.118	.146	.123	.165	.087	.160	.046
WHEELS/TIRES	13C	.446	.364	.210	.217	.307	.534	.469	.409
BRAKE SYSTEM	13D	.137	.150	.095	.115	.155	.146	.326	.107
STEERING SYSTEM	13E	.095	.127	.097	.020	.152	.089	.154	.134
LANDING GEAR CONTROLS	13F	-	.008	.012	.012	.016	.067	.025	.213
ARRESTING GEAR	13G	.011	-	.110	.079	.195	.162	.101	.058
CATAPULTING SYSTEM	13H	-	-	.069	.012	.006	.002	.130	.056
EMERGENCY SYSTEM	13J	.024	.106	.031	.056	.011	.015	.008	.010
FLIGHT CONTROLS	14	.291	.569	.527	.729	1.139	1.309	2.620	1.278
CONTROL STICK ASSEMBLY	14A	.006	.009	.016	.024	.114	.040	.019	.067
LATERAL CONTROL SYSTEM	14B	.122	.137	.101	.128	.360	.302	.470	.467
LONGITUDINAL CONTROLSYSTEM	14C	.062	.174	.103	.192	.211	.314	.255	.371
DIRECTIONAL CONTROL SYSTEM	14D	.037	.127	.057	.116	.089	.107	.156	.147
FLAPS/SLATS	14E	.037	.073	.134	.204	.235	.407	1.096	.209
SPEED BRAKE SYSTEM	14F	.011	.039	.042	.055	.063	.055	.032	-
WING SWEEP/INCIDENCE	14G	-	-	-	-	.059	-	.500	-
ENGINE	23	.738	.688	1.415	.787	1.436	1.265	3.579	.939
BASIC ENGINE	23A	.516	.526	1.086	.573	.996	.020	3.173	.630
ACCESSORY DRIVE SYSTEM	23B	.005	.004	.001	.003	-	.056	.001	.002
MAIN/AB FUEL SYSTEM	23C	.134	.119	.181	.071	.345	.198	.276	.168
LUBRICATION SYSTEM	23D	.052	.010	.026	.022	.024	.076	.027	.035
ELECTRICAL SYSTEM	23E	.001	.013	.043	.008	.014	.032	.036	.063
IGNITION SYSTEM	23F	-	.003	.004	.013	.007	.039	.025	.021
BLEED AIR SYSTEM	23G	.050	-	.017	.015	.050	.026	.014	.019
AUXILLARY POWER PLANT	24	.283	.274	-	-	-	-	-	.317
POWER PLANT INSTALLAION	29	.098	.271	.124	.284	.299	.264	1.355	.246
ENGINE MOUNT/SUSPENSION	29A	.002	-	0.060	.001	.016	.017	.069	.107
POWER PLANT CONTROLS	29B	.012	.164	.026	.059	.031	.124	.913	.040
IGNITION/STARTING SYSTEM	29C	-	-	.019	.004	.033	.047	.110	.008
EXHAUST SYSTEM	29D	.068	.098	.008	.113	-	.001	-	-
APPROACH POWER COMPENSATING	29E	.004	-	.056	.021	.147	.072	.195	-

Table A-1.2 Navy Fighter/Attack/ASW Aircraft Standard Work Unit Code Report Matrix of Navy Aircraft Class 1 MMH/FH O+I Level Data By 3 Digit SWUC

SYSTEM/SUB-SYSTEM	STD WUC	A-4M	AV8A	A-7E	A-6E	F-8J	F-4J	F14A	S-3A
AIR CONDITIONING	41	.058	.144	.173	.222	.319	.515	.547	.436
AIR CONDITIONING	41A	.034	.073	.154	.203	.083	.197	.204	.302
PRESSURIZATION	41B	.015	.041	.008	.008	.093	.080	.075	.011
ICE/RAIN/WASH CONTROL	41C	.008	.025	.001	.010	.003	.021	.034	.117
BOUNDARY LAYER CONTROL	41D	-	-	-	-	.136	.215	-	-
ELECTRICAL	42	.367	.996	.374	1.167	1.076	.764	.910	.524
GENERATOR DRIVE SYSTEM	42A	.143	.211	.010	.296	.143	.136	.346	.072
AC POWER SUPPLY	42B	.041	.128	.074	.158	.139	.310	.065	.102
DC POWER SUPPLY	42C	-	.502	.001	.163	-	.010	.010	.007
POWER DISTRIBUTION SYSTEM	42D	.009	.001	.065	.056	.094	.047	.165	.164
AIRCRAFT WIRING	42E	.166	.146	.215	.496	.699	.240	.322	.156
LIGHTING	44	.200	.094	.144	.162	.215	.259	.314	.210
EXTERIOR LIGHTING	44A	.130	.057	.064	.119	.131	.138	.230	.111
INTERIOR LIGHTING	44B	.068	.037	.079	.041	.084	.121	.072	.106
HYDRAULIC	45	.094	.260	.185	.303	.424	.564	.602	.171
NORMAL	45A	.094	.202	.136	.259	.236	.158	.462	.162
EMERGENCY/AUXILLARY	45B	-	.065	.041	.034	.150	.230	.206	.009
PNEUMATIC	45C	-	-	.001	-	.029	.166	-	-
FUEL	46	.147	.475	.218	.293	.396	.797	.749	.154
INTERNAL FUEL SYSTEM	46A	.066	.367	.102	.195	.335	.465	.673	.105
EXTERNAL FUEL SYSTEM	46B	.068	.106	.096	.049	-	.222	.004	.027
AERIAL REFUELING SYSTEM	46C	.006	.002	.015	.044	.061	.103	.040	.022
OXYGEN	47	.000	.114	.045	.069	.052	.072	.046	.050
MISCELLANEOUS UTILITIES	49	.008	.005	.028	.037	.039	.172	.092	.051
FIRE DETECTION	49A	.008	.005	.003	.013	.037	.055	.072	.051
FLIGHT RECORDER SYSTEM	49B	-	-	-	-	.001	-	-	-
ON-AIRCRAFT TEST EQUIPMENT	49C	-	-	-	-	-	-	.017	-
AIR DRIVEN TURBINE SYSTEM	49D	-	-	.025	.024	-	.115	-	-
INSTRUMENTS	51	.236	.496	.455	.712	.706	.516	1.028	.402
FLIGHT/NAV INSTRUMENTS	51A	.073	.153	.066	.307	.478	.103	.115	.070
ENGINE INSTRUMENTS	51B	.023	.056	.114	.074	.120	.066	.260	.142
FUEL QUANTITY INDICATION	51C	.059	.221	.177	.097	.120	.100	.403	.063
POSITION INDICATION	51D	.039	.039	.047	.056	.024	.040	.077	.035
UTILITY INDICATION	51E	.008	.016	.019	.027	.027	.027	.023	.017
ADVISORY/WARNING INDICATION	51F	.034	.010	-	.070	-	-	.141	.063
FLIGHT REFERENCE	56	.050	.179	.267	.255	.141	.090	1.294	.266
ANGLE OF ATTACK INDICATION	56A	.020	.014	.129	.052	.129	.145	.077	.047
AIR DATA COMPUTER	56B	.018	.163	.123	.021	-	.405	.906	.200
ATTITUDE HEADING AND REFERENCE	56C	.010	-	.014	.175	.012	.256	.112	.010
INTEG GUIDANCE/FLIGHT CONTROL	57	.076	.283	.339	.178	.950	.427	.569	.443

Table A-1.3 Navy Fighter/Attack/ASW Aircraft Standard Work Unit Code Report
Matrix of Navy Aircraft Class 1 MMH/FH O+I Level Data By 3 Digit SWUC

S Y S T E M / S U B - S Y S T E M	STD WUC	A-4M	AV8A	A-7E	A-6E	F-8J	F-4J	F14A	S-3A
COMMUNICATIONS	60	.346	.397	.467	.032	.464	1.077	1.591	.991
VHF COMMUNICATIONS	62	.007	.084	-	-	-	-	-	-
UHF COMMUNICATIONS	63	.210	.151	.297	.456	.244	.693	.310	.095
INTERPHONE	64	-	-	.015	.050	-	.050	.040	.515
IFF	65	.045	.111	.004	.100	.139	.190	.239	.107
EMERGENCY RADIO	66	-	-	.003	.005	.002	.006	.007	.011
CNI	67	.004	.046	.009	.130	.079	.095	.001	.075
MISCELLANEOUS COMMUNICATIONS	69	-	.005	.050	.003	-	.027	.090	.079
RADIO NAVIGATION	71	.134	.299	.361	.302	.591	.466	.150	.355
DIRECTION FINDER GROUP/SET	71A	.008	-	.016	.006	.020	.023	-	.030
TACAN SET	71C	.098	.286	.216	.154	.445	.380	.101	.050
RECEIVING DECODER GROUP	71D	-	-	.035	.132	.072	.020	.034	.007
ASSOCIATED EQUIPMENT	71Q	.023	.013	.005	.004	.042	.025	.011	.250
RADAR NAVIGATION	72	.197	.082	.467	1.714	.153	.271	.070	.602
RADAR ALTIMETER SET	72A	.136	.074	.182	.263	.140	.259	.042	.112
DOPPLER RADAR NAV SET	72B	.018	-	.223	.247	-	-	-	.066
RADAR BEACON SET	72D	.030	-	.048	.002	-	.007	.016	.004
RADAR SETS	72E	.010	-	-	1.139	-	-	-	.309
ASSOCIATED EQUIPMENT	72P	-	-	.010	.039	.004	-	.009	.105
BOMBING NAVIGATION	73	.426	.906	1.314	2.150	.057	.403	.708	3.101
NAV COMPUTER SET	73A	.397	-	-	-	-	.397	-	-
INERTIAL NAV SYSTEM	73D	-	.406	.582	.930	-	-	.779	1.028
DISPLAY SET	73H	-	.401	.308	.473	-	-	-	-
MISCELLANEOUS SET/GROUP	73P	-	-	.357	.312	.056	-	-	2.071
ASSOCIATED EQUIPMENT	73R	.024	-	.009	.401	-	-	-	.092
WEAPONS CONTROL	74	.169	.048	.695	.244	1.440	4.500	3.994	.030
RADAR SET	74A	-	-	.517	-	1.223	4.353	-	-
FIRE CONTROL SET	74C	-	-	-	-	.215	.057	.375	-
FUSE FUNCTION CONTROL SET	74D	.029	-	.017	.008	-	-	.005	-
AN/AWG-9 SYSTEM	74E	-	-	-	-	-	-	3.440	-
WEAPONS RELEASE CONT EQUIP	74F	.134	.030	.069	.000	-	.020	-	-
ASSOCIATED EQUIPMENT	74M	.004	.010	.055	.100	-	.007	.006	-
MISCELLANEOUS SET/EQUIPMENT	74P	-	-	-	.100	-	.027	-	.030
WEAPONS DELIVERY	75	.341	.162	.448	.113	.190	.416	.600	.057
LAUNCHERS/RACKS/RAILS	75A	.230	.046	.284	.103	.052	.200	.302	.057
GUN	75B	.091	.057	.115	-	.121	-	.105	-
PYLONS	75C	-	.057	.043	-	.000	.116	.190	-
ECM	76	.102	-	.261	.322	.765	.377	.752	.122
ECM SYSTEM/SET/EQUIPMENT	76A	.051	-	.099	.104	.407	.116	.332	-
CHAFF DISPENSING SET	76B	.004	-	.026	.011	.047	.034	.051	-
RADAR SET	76D	.003	-	-	-	.200	-	.001	-
RADAR RECEIVER SET	76E	.045	-	.022	.054	-	.057	.001	-
ECM RECEIVER SET	76K	-	-	.006	.123	-	.150	.194	.122
ASSOCIATED EQUIPMENT	76Q	-	-	.016	.019	.025	.013	.032	-
PHOTO	77	-	.010	.006	.001	.014	.006	-	.372

Table A-1.4 Navy Fighter/Attack/ASW Aircraft Standard Work Unit Code Report
Matrix of Navy Aircraft Class 1 MMH/FH O+I Level Data By 3 Digit SWUC

SYSTEM/SUB-SYSTEM	STD WUC	A-4M	AV8A	A-7E	A-6E	F-8J	F-4J	F14A	S-3A
MISCELLANEOUS EQUIP/ SYSTEMS	90	.008	.048	.035	.042	.037	.137	.055	.167
EMERGENCY EQUIPMENT	91	.027	.003	.012	.026	.025	.046	.041	.060
DRAG CHUTE EQUIPMENT	93	.010	-	-	-	-	.016	-	-
PERSONNEL EQUIPMENT	96	.004		0.000	.001	.003	-	.002	-
EXPLOSIVE DEVICES	97	.031	.045	.023	.015	.009	.075	.012	.099
TOTAL UNSCHEDULED		5,716	0,610	10,477	12,792	13,047	19,059	25.905	13.702
OPERATIONAL SUPPORT	01	3.712	5.523	8.044	8.073	11.002	9.597	11.457	8.068
OPERATIONAL SUPPORT	010	.538	1.217	3.688	3.986	3.126	5.270	.349	.980
GROUND HANDLING	011	.751	1.063	1.194	1.529	2.010	1.511	2.098	2.684
SERVICING	012	.955	1.136	1.033	1.022	2.162	1.102	1.656	.040
MISSION CONFIGURATION	013	.667	1.477	.533	.632	1.300	.546	.576	.460
GROUND SAFETY	014	.152	.235	.114	.227	.020	.164	.218	.207
MANNING STANDBY A/C	015	.179	.310	.405	.041	1.030	.486	.607	.912
TROUBLESHOOT LAUNCH A/C	016	.486	.023	.014	.616	1.160	.398	1.754	1.513
INERTIAL NAV SYSTEM	017	.001	.060	.019	.041	.002	.080	.072	.033
FOD WALKDOWN	018	.046	-	.136	.021	.254	.030	.111	.337
OTHER	019	.017	-	.135	.003	.010	.005	.036	.002
CLEANING	02	.074	.283	.221	.144	.299	.334	.155	.228
INSPECTIONS	03	3.275	5.193	3.788	6.597	5.921	7.647	8.937	4.182
TURNAROUND/PREFLIGHT	03C	.593	.826	.756	1.615	.600	1.420	1.613	1.410
DAILY/SPECIAL (D,M)	030	1.447	2.397	1.895	3.001	2.694	3.601	4.076	1.789
PHASE (G,P,Q)	036	.781	.928	.621	.981	1.723	1.166	1.306	.341
CONDITIONAL	035	.056	.259	.268	.478	.213	.754	.641	.184
OTHER (HEARTFLUB)	032	.478	.783	.248	.442	.011	.610	1.219	.378
CORROSION PREVENTION	04	.223	1.305	1.752	1.151	1.540	1.906	3.370	.021
SHOP SUPPORT	05	1.011	2.291	.696	.992	-	2.077	2.412	1.109
GENERAL FUNCTIONS	050	.332	1.364	.268	.373	.967	.058	.708	.537
ENGINE BUILD UP	060	.460	.029	.009	.164	.004	.516	.006	.026
MISSION SHOP SUPPORT	070	.002	.439	.275	.330	.711	.437	.463	.276
SAFETY/SURVIVAL EQUIPMENT	080	.071	.032	.028	.105	.017	.096	.210	.137
NON-AERO WORK	090	.058	.427	.096	.020	.096	.170	.065	.133
TOTAL AIRCRAFT		14.011	23.125	25.018	29.749	35.292	40.700	52.236	20.022

APPENDIX B

AIRCRAFT MA/FH DEFECT RATIO DATA

Table B-1 Navy Fighter/Attack/ASW Aircraft Standard Work Unit Code Report
Navy Aircraft Class 1 Versus Class 2 Defect Ratio - MA/FH O Level

SYSTEM	STD WUC	A-4M	AV8A	A-7E	A-6E	F-8J	F-4J	F14A	S-3A	CUM. AVG.
AIRFRAME	11	.667	.833	.923	.812	.897	.853	.730	.803	.815
FUSELAGE	12	.667	.500	.538	.679	.658	.727	.761	.602	.661
LANDING GEAR	13	.870	.846	.847	.782	.917	.899	.744	.784	.836
FLIGHT CONTROLS	14	.769	.553	.773	.722	.885	.812	.585	.500	.691
ENGINE	23	.667	.667	.639	.614	.732	.614	.496	.563	.624
AUXILLARY POWER PLANT	24	.514	.517	-	-	-	-	-	.542	.524
POWER PLANT INSTALLAION	29	.786	.667	.786	.704	.821	.750	.530	.582	.695
AIR CONDITIONING	41	.632	.609	.719	.625	.726	.726	.667	.347	.631
ELECTRICAL	42	.625	.875	.761	.631	.885	.693	.639	.627	.707
LIGHTING	44	.862	.885	.833	.819	.849	.829	.874	.760	.830
HYDRAULIC	45	.722	.605	.825	.787	.815	.783	.667	.571	.712
FUEL	46	.647	.750	.654	.656	.709	.655	.601	.542	.662
OXYGEN	47	.600	.800	.786	.714	.733	.786	.765	.615	.737
MISCELLANEOUS UTILITIES	49	1.000	1.000	.667	.714	1.000	.444	.530	.857	.778
INSTRUMENTS	51	.702	.682	.685	.568	.712	.726	.639	.525	.655
FLIGHT REFERENCE	56	.556	.619	.696	.511	.816	.631	.469	.478	.597
INTEG GUIDANCE/FLIGHT CONTROL	57	.636	.688	.692	.640	.817	.675	.434	.375	.620
COMMUNICATIONS	60	.574	.618	.664	.617	.587	.618	.585	.462	.598
RADIO NAVIGATION	71	.423	.447	.635	.636	.623	.649	.394	.308	.524
RADAR NAVIGATION	72	.520	.667	.537	.553	.500	.591	.529	.500	.550
BOMBING NAVIGATION	73	.544	.600	.568	.468	.500	.542	.421	.458	.513
WEAPONS CONTROL	74	.632	.583	.615	.681	.675	.789	.451	.429	.597
WEAPONS DELIVERY	75	.615	.720	.747	.621	.757	.685	.363	.769	.658
ECM	76	.583	-	.656	.647	.731	.513	.609	.429	.596
PHOTO	77	-	.750	.500	-	.500	0.000	-	.405	.431
MISCELLANEOUS EQUIP/ SYSTEMS	98	.556	.857	.857	.583	.875	.833	.586	.548	.712
TOTAL UNSCHEDULED		.714	.716	.721	.647	.833	.734	.601	.500	.683
TURNAROUND/PREFLIGHT	03C	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
DAILY/SPECIAL (D,M)	03D	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PHASE (G,P,Q)	03G	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CONDITIONAL	03S	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
OTHER (NEARTFLUB)	03Z	-	-	-	-	-	-	-	-	-
TOTAL INSPECTIONS		.924	.940	.929	.946	.902	.953	.976	.973	.944
OPERATIONAL SUPPORT	01	.519	.320	.273	.265	-	-	.392	.320	.340
CLEANING	02	-	-	-	-	-	-	-	-	-
CORROSION PREVENTION	04	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SHOP SUPPORT	05	-	-	-	-	-	-	-	-	-
TOTAL SUPPORT		.473	.334	.295	.271	.396	.391	.430	.306	.362
TOTAL AIRCRAFT		.656	.490	.470	.496	.592	.611	.605	.462	.550

Table B-2 Navy Fighter/Attack/ASW Aircraft Standard Work Unit Code Report
Navy Aircraft Class 1 Versus Class 2 Defect Ratio - MA/FH I Level

SYSTEM	STD WUC	A-4M	AV8A	A-7E	A-6E	F-8J	F-4J	F14A	S-3A	CUM. AVG.
AIRFRAME	11	1.000	1.000	1.000	1.000	1.102	1.000	.989	1.000	1.011
FUSELAGE	12	1.000	1.000	.500	1.000	.500	1.000	1.000	1.000	.875
LANDING GEAR	13	1.000	.978	.971	.960	.984	.992	.975	.970	.980
FLIGHT CONTROLS	14	1.000	.909	.980	.800	.889	.875	.864	1.000	.905
ENGINE	23	.857	1.000	.833	.867	.750	.630	.173	.889	.750
AUXILLARY POWER PLANT	24	.800	.500	-	-	-	-	-	.846	.715
POWER PLANT INSTALLAION	29	.800	1.000	.800	.875	.800	.800	.760	1.000	.857
AIR CONDITIONING	41	1.000	1.000	.818	.980	.895	.909	.929	.615	.843
ELECTRICAL	42	.889	.830	.800	.697	.737	.780	.667	.889	.776
LIGHTING	44	.938	.667	.857	.833	.875	.500	.667	.909	.781
HYDRAULIC	45	1.000	1.000	1.000	1.000	.944	1.000	.857	1.000	.975
FUEL	46	1.000	.923	1.000	1.000	.857	.889	1.000	1.000	.959
OXYGEN	47	.833	.714	1.000	.750	.750	1.000	.857	.800	.830
MISCELLANEOUS UTILITIES	49	-	-	1.000	1.000	-	.500	.500	1.000	.800
INSTRUMENTS	51	.867	.848	.852	.800	.765	.846	.829	1.000	.858
FLIGHT REFERENCE	56	1.000	.875	.909	.833	.875	.800	.759	.929	.873
INTEG GUIDANCE/FLIGHT CONTROL	57	.750	.700	.750	.714	.891	.846	.680	.722	.758
COMMUNICATIONS	60	.760	.652	.750	.790	.674	.765	.724	.792	.738
RADIO NAVIGATION	71	.400	.471	.778	.714	.682	.735	.385	.788	.689
RADAR NAVIGATION	72	.667	.800	.673	.750	.448	.567	.800	.867	.696
BOMBING NAVIGATION	73	.652	.636	.742	.756	.667	.655	.771	.837	.715
WEAPONS CONTROL	74	.800	1.000	.865	.909	.705	.767	.612	1.000	.835
WEAPONS DELIVERY	75	.923	.429	.833	.889	.950	.778	.588	.500	.736
ECM	76	1.000	-	.833	.846	.804	.727	.739	1.000	.858
PHOTO	77	-	-	0.000	-	-	1.000	-	.909	.636
MISCELLANEOUS EQUIP/ SYSTEMS	90	1.000	-	1.000	1.000	1.000	.833	1.000	1.000	.976
TOTAL UNSCHEDULED		.868	.812	.867	.807	.820	.818	.730	.858	.824
TURNAROUND/PREFLIGHT	03C	-	-	1.000	-	-	-	1.000	1.000	1.000
DAILY/SPECIAL (D,M)	03D	1.000	-	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PHASE (G,P,Q)	03G	1.000	1.000	0.000	1.000	-	1.000	1.000	-	.833
CONDITIONAL	03S	1.000	1.000	0.000	-	-	1.000	1.000	-	.800
OTHER (HEARTFLUB)	03Z	-	-	-	-	-	-	-	-	-
TOTAL INSPECTIONS		.949	.273	.571	.200	1.000	.300	.261	.400	.495
OPERATIONAL SUPPORT	01	-	-	0.000	-	-	-	.706	.960	.505
CLEANING	02	-	-	-	-	-	-	-	-	-
CORROSION PREVENTION	04	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SHOP SUPPORT	05	-	-	-	-	-	-	-	-	-
TOTAL SUPPORT		.052	.304	.322	.144	.014	.032	.239	.575	.214
TOTAL AIRCRAFT		.577	.442	.747	.579	.275	.304	.372	.741	.515

APPENDIX C

STANDARD WORK UNIT CODE (SWUC) MATRIX

Table C-1.1 SWUC Matrix

SYSTEM	STD WUC	A-4M	A-6E	A-7E	AV-8A
AIRFRAME	11	11, (-1139)	11, (-11A)	11, 121, 492	11, 121
Structure	11A	110, 111, 112, 1132, 11A1, 115	1111, 1114, 1116, 1117, 112, 113, 117, 118, 119, (-11216)	1111, 1112, 1115/6, 1121/3, 1131/3, 11A1/3, 11A4/6, 1151	1111, 1113, 1121, 1131, 11A1, 1151, 1161
Access Doors/Panels	11B	1131, 1133	1113, 11216	1114, 1117/8, 1119/A, 1122, 1132/4, 1142, 1145, 1152	1112, 1122, 1123, 1133, 1134, 1142, 1152, 1162
Windshield	11C	1134	11121	1113	1124
Canopy	11D	1136, 1137, 1139	11122, 114	121	121
Wingfold	11E	N/A	119	492	N/A
FUSELAGE	12	12, 1135	12	12, (-121)	12, (-121)
Ejection Seat Instl	12A	121, 122, 123, 124	121, 123	122, 126	122
Cockpit Equip	12B	1135, 125	122	125, 124	123
LANDING GEAR	13	13, (-1351)	13, 11A	13, (-1343)	13
MLG and Doors	13A	1311, 1312, 1313 13411→13414, 13425→1342C, 13438→1343M	131, 11A	1311, 1312, 1321,	131
NLG and Doors	13B	1321, 1322 13415→13417 13421→13424 13431→13437	132	1314, 1315, 1322	132
Wheels/Tires	13C	1314, 1323	135	1313, 1316	135
Brake System	13D	1371	136	1351, 1352, 1355	137, 138
Steering System	13E	133	137	136	139
LDG Controls	13F		134, -1345	1341, 1342, 1344	136
Arresting Gear	13G	1382	138	138	N/A
Catapulting System	13H	1381	139	137	N/A
Emergency System	13J	136	1345	133, 1353, 1354	N/A
FLIGHT CONTROLS	14	14, (-148)	14	14, (-1478), (-1455)	14
Control Stick Assy	14A	141	142	141	144
Lateral Control System	14B	142, 14A, 14914	1411, 143, 149	142, 143	141
Longitudinal Control System	14C	143, 146, 1491A, 1491D	1413, 145, 14B	145, (-1455)	143
Directional Control System	14D	147, 1491C	1412, 144, 14A	144	142
Flaps/Slats	14E	145, 14917, 14918	1414, 146, 148, (-14143)	147, (-1478)	145
Speed Brake System	14F	144, 14915, 14916	14143, 147	146	146
Wing Sweep System	14G	N/A	N/A	N/A	N/A
ENGINE	23	23	23	23	27
Basic Engine	23A	2350, 2351, 2352, 2353, 238	2350, 2351, 2352, 2353	23D0, 23D1, 23D2, 23D3, 23D4	2720, 2721, 2722, [illegible], 2724
Accessory Drive System	23B	2355	2355	23D5	2725
Main Fuel System	23C	2356	2356	23D6	2726
Lubrication System	23D	2358	2358	[illegible]	2728
Electrical System	23E	2359	2359	23D9	2729
Ignition System	23F	235A	235A	23DA	272A
Bleed Air System	23G	235B	235B	[illegible]	272B
AUXILIARY POWER UNIT	24	2952	N/A	N/A	24P
POWER PLANT INSTL	29	29, (-2952)	29	29, (-298)	29, (-292)
Engine Mount/Suspension	29A	291	291	291	
Power Plant Controls	29B	293	293	293	291
Ignition Starting System	29C		295	295	
Exhaust System	29D	296	296	296	[illegible]
Approach Power Compensating	29E	29C	29C	29C	

Table C-1.2 SWUC Matrix

SYSTEM	STD WUC	A-4M	A-6E	A-7E	AV-8A
AIR CONDITIONING	41	41,493	41,493	41,494	41,492
Air Conditioning	41A	411, 414, 415	411	411	411, 419
Pressurization	41B	412, 416	413	412	412, 414
Ice/Rain/Wash Control	41C	413, 493	412, 493	4132, 494	491
Boundary Layer Control	41D	N/A	N/A	N/A	N/A
ELECTRICAL	42	42	42, (-4242)	42	42
Generator Drive System	42A	4284, 4225	4214	421	4211, 4212
AC Power Supply	42B	4221, 423	4211, 423, 424, (-4242)	4221, 424	4213, 4214, 4215, 4216
DC Power Supply	42C	424	422	4222	422
Power Distribution System	42D	421	4212, 4213	423	424
Aircraft Wiring	42E	428	428	428	428
LIGHTING	44	44	44	44	44
Exterior Lighting	44A	441	441	441	442
Interior Lighting	44B	442	442	442	441, 443
HYDRAULIC	45	45, (-451441), (-455441)	45, (-4528)	45, (-4513, 4523, 4532)	45
Normal	45A	45, (-451441), (-455441)	4521, 4523	451, 452, 454, (-4513), (-4522)	451, 452
Emergency/Auxiliary	45B		4524, 4526	453, (-4532)	453
Pneumatic	45C			455	
FUEL	46	46, (-466)	46	46, (-466)	46
Internal Fuel System	46A	461, 462, 463, 465	4611, 462, 463, 464	461, 462, 463	4611 4617, 462, 469
External Fuel System	46B	464, 46A, 46C	4612	465, 46A, 46C	4618, 4619
Aerial Refueling System	46C	467	465, 466, 46A/B/C	464	464
OXYGEN	47	47, (-47214)	47	47	47
MISC. UTILITIES	49	49, (-493)	49, 4528, (-492/3)	49, 911, (-492/4)	49, (-491), (-493)
Fire Detection	49A	491	491	491	492
Flight Recorder System	49B	N/A	494	N/A	N/A
On-Aircraft Test Equipment	49C	N/A	N/A	N/A	N/A
Air Driven Turbine Systems	49D	N/A	4528, 4242	911	N/A
INSTRUMENTS	51	51, 1351, 148, 451441, 455441, 466, 47214	51, 492, (-5114)	51, 1343, 1455, 1479, 298, 4513, 4523, 4532, 466, (-5114)	51, (-5115), 493
Flight/Nav Instruments	51A	511, 513, 5141A, 5141B, 515	5111, 5112, 5113, 512, 513	51110, 51111, 51112, 51113, 51119, 5112, 5113, 5115, 5116, 5121	5111, 5113, 5114, 516
Engine Instruments	51B	512	514	5111A 5111B, 5111D, 5111E, 5111F, 299	512
Fuel Quantity Indication	51C	51415, 466	517	5111A, 466	513
Position Indication (13,14)	51D	1351, 148	516	1343, 1495, 1478	514, 5112
Utility Indication (45,47)	51E	451441, 455441, 47214	515	5111B, 5111C, 4513, 4523, 4532	515
Advisory/Warning Indication	51F	514, (-51415)	492		493
FLIGHT REFERENCE	56	56	56, 5114	56, 5114, 7346	56, 5115
Angle of Attack Indication	56A	568	5114	5114	5115
Air Data Computer	56B	565	565A0	5689, 7346	569
Attitude Heading & Reference	56C	56X	56X1, 568	5685, 56X1	
INTEG GUID/FLIGHT CONTROL	57	57	57	57	57
COMMUNICATIONS	60	6X	6X, (-67X16), (-67X19)	6X	6X
VHF Communication	62	62	N/A	N/A	62

Table C-1.3 SWUC Matrix

SYSTEM	STD WUC	A-4M	A-6E	A-7E	AV-8A
UHF Comm.	63	63, (-6351)	63, 63X15, (-6351)	63, (-6351)	63
Interphone	64	64	64	64	N/A
IFF	65	65	65, 67X12	65	65
Emergency Radio	66	66	66	66	66
CNI	67	67	67, (-67X12), (-67X15), (-67X16), (-67X18)	67	67, (-67[illegible])
Misc. Comm.	69	6351	69, 6951	69, 6951	[illegible]
RADIO NAVIGATION	71	71	71, 67X16, 67X18	71	71
Direction Finder Group/Set	71A	7116	7116	7116	N/A
TACAN Set	71C	713C	67X16	713C, 71A3	71[illegible], 71[illegible]
Receiving Decoder Group	71D	N/A	67X18	71[illegible]	N/A
Assoc. Equipment	71R	71X1, 714	71X1	71X1	71X1
RADAR NAVIGATION	72	72	72, (-72[illegible])	72, 73A3	72
Radar Altimeter Set	72A	7236, 72[illegible]	72[illegible], 7236	72[illegible], 7236	72[illegible], 72[illegible]
Doppler Radar Nav. Set	72B	7238	7238	73A3	N/A
Radar Beacon Set	72D	7239	7239	7239	N/A
Radar Set	72E	7219	7245, 72[illegible]	N/A	N/A
Assoc. Equipment	72F	72X1, 72Y1	72[illegible], 72[illegible]	72X1	N/A
BOMBING NAVIGATION	73	73	73, 72[illegible]	73, (-73A1/3/6)	73
Nav. Computer Set	73A	731, 739	N/A	N/A	N/A
Inertial Nav. System	73D	N/A	7345	73A5	73[illegible]
Display Set	73E	N/A	72[illegible]	73A4	73[illegible], 73[illegible]
Misc. Set/Group	73F	N/A	736A	735A, 7[illegible]	N/A
Assoc. Equipment	73R	73R, 73X	73[illegible]	73X1	N/A
WEAPONS CONTROL	74	74	74	74, 73A1	74
Radar Set	74A	N/A	N/A	73A1	N/A
Fire Control Set	74C	N/A	N/A	N/A	N/A
Fuse Function Control Set	74D	7495	74[illegible]	7496	N/A
AN/AWG-9 System	74E	N/A	N/A	N/A	N/A
Weapons Release Cont. Equip.	74F	7475, 7495	7495	7497	74[illegible]
Assoc. Equipment	74M	74X1	74X1	74Y1	N/A
Misc. Set/Equipment	74P	N/A	7493	N/A	7463
WEAPONS DELIVERY	75	75	75	75	75
Launchers/Racks/Rails	75A	754, 755, 759	754, 755	751, [illegible]53	754, 755, 75[illegible]
Gun	75B	753, 758	758	755	757
Pylons	75C	N/A	N/A	756	75[illegible]
ECM	76	76	76	76	N/A
ECM System/Set/Equip.	76A	7631, 767	7673, 767L	7673, 767L	
Chaff Dispensing Set	76B	7665	7665	7665	
Radar Set	76D	7669	N/A	N/A	
Radar Receiver Set	76E	7666	76[illegible], 7666	76[illegible]	
ECM Receiver Set	76K	N/A	76[illegible]	76[illegible]	
Assoc. Equip.	76R	N/A	76X1	76[illegible], 76X3	
PHOTO/RECON	77	N/A	N/A	77	77
MISC. EQUIP./SYSTEMS	90	9X	9X	9X, (-911)	9X
Emergency Equip.	91	91	91	912	91
Drag Chute Equipment	93	93	N/A	N/A	N/A
Personnel Equipment	96	N/A	96	96	96
Explosive Devices	97	97	97	97	97

Table C-1.4 SWUC Matrix

SYSTEM	STD WUC	F-4J	F-8J	F-14A	S-3A
AIRFRAME	11	11, 123, 148	11, 121, 493	11, 129, (-1125/6)	11
Structure	11A	1111, 1115, 1118, 1121, 1123, 113, (-11114) (-11113)	1111/2, 1115/7/8, 1121/3, 1125/6, 1131/3, 1135/6, 1141/2, 1151/3, 1154/6	1112/4/7/8, 1121, 1132, 1135/6/7, 1141, 1151, 116, 118	1111/2, 1113/6/7, 112, 1131/3, 11910→11913 1141, 1151/2
Access Doors/Panels	11B	1112/3/4, 1116/7/9 1116, 1122, 1124	1114/6, 1122/4, 1132/4 1143, 1152/5	1115/6/9, 1122/3/4 1132/3/4, 1144, 1152	1113, 1132, 1142, 1151A→11919
Windshield	11C	11114	1113	1113	1114
Canopy	11D	11113, 1112, 123	121	1111, 125	
Wingfold	11E	148	493	N/A	119
FUSELAGE	12	12, (-123)	12, (-121)	12, (-125)	12
Ejection Seat Instl	12A	122	122	121	121
Cockpit Equip	12B	121	129	122, 123, 124	123
LANDING GEAR	13	13	13, (-1368)	13	13
MLG and Doors	13A	1321, 1323	131	131, 132	139, (-1393)
NLG and Doors	13B	1331, 1332	132	133, 134	132, (-1323)
Wheels/Tires	13C	1325, 1333	134	135	1383, 1393
Brake System	13D	134	135, 1372	138	1361, 1362, 1364, 1365
Steering System	13E	1334, 1335	133	139	133
LDG Controls	13F	131	136, 1371, (-1363)	136	1311, 1312, 1313
Arresting Gear	13G	135	138, (-1385)	13A	137
Catapulting System	13H	136	1385	13B	134
Emergency System	13J			137	1314, 1363
FLIGHT CONTROLS	14	14, (-148)	14, (-149), (-14641)	14	14
Control Stick Assy	14A	141	141, (-1415)	141	14110→1411A
Lateral Control System	14B	142	142	142	143
Longitudinal Control System	14C	143	144	144	1411B→14119,1412/3,142
Directional Control System	14D	144	143	143	145, 146
Flaps/Slats	14E	145	146, 147, (-14641)	146	147, 148
Speed Brake System	14F	146	148	147	
Wing Sweep System	14G	N/A	N/A	148	N/A
ENGINE	23	23	23	23	27
Basic Engine	23A	23A0, 23A1, 23A2, 23A3, 23A4	2360, 2361, 2362, 2363, 2364	2380, 2382, 2383, 2384	2710, 2711, 2712, 2713, 2714
Accessory Drive System	23B	23A5	2365	2385	2715
Main Fuel System	23C	23A6, 23A7	2366, 2367	2386, 2387	2716
Lubrication System	23D	23A8	2368	2388	2718
Electrical System	23E	23A9	2369	2389	2719
Ignition System	23F	23AA	236A	238A	271A
Bleed Air System	23G	23AB	236B	238B	271B
AUXILIARY POWER UNIT	24	N/A	N/A	N/A	24, 29A
POWER PLANT INSTL	29	29	29	29	29, (-29A)
Engine Mount/Suspension	29A	291	291	291	291, 292
Power Plant Controls	29B	293	293	292/3, 297/8, 29C	293
Ignition Starting System	29C	295	295	295	294
Exhaust System	29D	296			
Approach Power Compensating	29E	29C	29C	29C	

Table C-1.5 SWUC Matrix

SYSTEM	STD WUC	F-4J	F-8J	F-14A	S-3A
AIR CONDITIONING	41	41	41, 149	41, 493	41, 401/2/3/4
Air Conditioning	41A	411, 414, 416, 417	411, 412, 413	411	411
Pressurization	41B	412	414, 416	413, 41X1	412
Ice/Rain/Wash Control	41C	413	415	415, 493	413, 401/2/3/4
Boundary Layer Control	41D	415	149	N/A	N/A
ELECTRICAL	42	42	42	42	42
Generator Drive System	42A	422	421	4211	42111, 42112, 42113
AC Power Supply	42B	4212, 421A	422, (-42216/21/27/2X)	4212, 422, 4215	42114 → 42119
DC Power Supply	42C	4213, 4216	42216/21/27/2X	4213	422
Power Distribution System	42D	4221, 4225	425	423, 425	424
Aircraft Wiring	42E	428	428	428	429
LIGHTING	44	44	44	44	44
Exterior Lighting	44A	442	441	441	441
Interior Lighting	44B	441	442	442, 44X	442
HYDRAULIC	45	45, (-453)	45, (-4511F)	45	45
Normal	45A	4511, 4512	451	4511, 4513, 4514	451, 452, 453
Emergency/Auxiliary	45B	4513, 4514, 455	452	4515, 4516	454
Pneumatic	45C	452	453		
FUEL	46	46, (-464)	46	46	46
Internal Fuel System	46A	461	462/3/4/5/9	461	461/2/3/4/9
External Fuel System	46B	462, 465, 46A, 46C	46A	462	466
Aerial Refueling System	46C	463	462	463	465
OXYGEN	47	47	47, (-472)	47	47
MISC. UTILITIES	49	49, 493	49, (-493)	49, 59, (-490/3/X1)	49, (-491/2/3/4/6)
Fire Detection	49A	491	491	490	495, 498
Flight Recorder System	49B	N/A	492	N/A	N/A
On-Aircraft Test Equipment	49C	N/A	N/A	495, 59	N/A
Air Driven Turbine Systems	49D	493		N/A	N/A
INSTRUMENTS	51	51, 464	51, 14641, 4511F, 472 (-5110), 1363	51, 492, 49X1	51, 496, (-5112)
Flight/Nav Instruments	51A	511, 512	511, 512, (-5110)	511, 512	5111
Engine Instruments	51B	514	519	513	513
Fuel Quantity Indication	51C	5184, 464	514	5192	515
Position Indication (13,14)	51D	516, 517	513, 14641, 1363	514, 5194	514
Utility Indication (45,47)	51E	5181, 5182, 5185	4511F, 472	5151, 5153	516, 517, 519
Advisory/Warning Indication	51F	N/A	N/A	492, 49X1	496
FLIGHT REFERENCE	56	56	56, 5119	56	56, 5112
Angle of Attack Indication	56A	5686	5119	568, 56X1C, 56X1D	5112
Air Data Computer	56B	564		56X18, 56X25	567
Attitude Heading & Reference	56C	562, 56X1	56X1	56X17	56X
INERT GUID/FLIGHT CONTROL	57	57	57	57	57
COMMUNICATIONS	60	6X, (-671X1), (-6717)	6X	6X	6X
VHF Communication	62	N/A	N/A	N/A	N/A

Table C-1.6 SWUC Matrix

SYSTEM	STD WUC	F-4J	F-8J	F-14A	S-3A
UHF Comm.	63	63,67120,67XXF/G/J, (-6351)	63	63	63, (-6351)
Intercom	64	64	N/A	64	64
IFF	65	65, 67XX1	65	65	65
Emergency Radio	66	66	66	66	66
CNI	67	67,(-67120/G), (-6717), (-67XX1), (-67XXF/G/J)	67	67	67
Misc. Comm.	69	6351	N/A	69	69, 6351
RADIO NAVIGATION	71	71, 6712M, 6717	71	71	71
Direction Finder Group/Set	71A	7116	7113	7116	7116, 7148
TACAN Set	71C	6712M, 6717	7149	713, 714	713C
Receiving Decoder Group	71D	71XL	71XL	71XL	71XL
Assoc. Equipment	71R	71X1, 717	71X1	71X1	71X5, 71X2
RADAR NAVIGATION	72	72	72	72	72
Radar Altimeter Set	72A	7236, 722B	72B4	722B	722E
Doppler Radar Nav. Set	72B	N/A	N/A	N/A	722F
Radar Beacon Set	72D	7239	N/A	7239	729D
Radar Set	72E	N/A	N/A	N/A	727E, 729F
Assoc. Equipment	72F	72X1	72X1	72X1	72X1, 72X1
BOMBING NAVIGATION	73	73	73	73	73
Nav. Computer Set	73A	7312, 7349	N/A	N/A	N/A
Inertial Nav. System	73D	N/A	N/A	734E	734E, 73B6
Display Set	73E	N/A	N/A	N/A	N/A
Misc. Set/Group	73F	N/A	73XX	N/A	73, (-734E/B6/X8)
Assoc. Equipment	73R	N/A	N/A	73X7	73XE
WEAPONS CONTROL	74	74	74	74	74
Radar Set	74A	7486, 7487, 74XB	7433, 7436, 7445	N/A	N/A
Fire Control Set	74C	74XR	7470	743D	N/A
Fuse Function Control Set	74D	N/A	N/A	74XR	N/A
AN/AWG-9 System	74E	N/A	N/A	74A	N/A
Weapons Release Cont. Equip.	74F	749	N/A	N/A	N/A
Assoc. Equipment	74M	74X2	N/A	74X1, 74X1, 74X1	N/A
Misc. Set/Equipment	74P	74X1	N/A	N/A	74
WEAPONS DELIVERY	75	75	75	75, 1185/6	75
Launchers/Racks/Rails	75A	751, 752, 753	752, 759	751, 752, 753	751, 752
Gun	75B	758	754	756	N/A
Pylons	75C	757	755	1185/6	N/A
ECM	76	76	76	76	76
ECM System/Set/Equip.	76A	7673, 767L	7673	7673	N/A
Chaff Dispensing Set	76B	7665	7665	7665, 766M	N/A
Radar Set	76D	N/A	7663, 7664, 766B	7663	N/A
Radar Receiver Set	76E	765W, 7666	N/A	765W, 7666	N/A
ECM Receiver Set	76K	765L, 763	N/A	765L	76X6
Assoc. Equip.	76R	76X5, 76X3	76XE	76X4, 76K	N/A
PHOTO/RECON	77	77	77	N/A	77
MISC. EQUIP./SYSTEMS	90	9X	9X	9X	9X
Emergency Equip.	91	91	91	91	91
Drag Chute Equipment	93	93	N/A	N/A	N/A
Personnel Equipment	96	96	96	96	96
Explosive Devices	97	97	97	97	97

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